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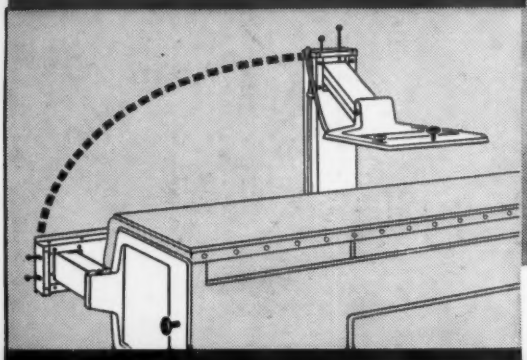

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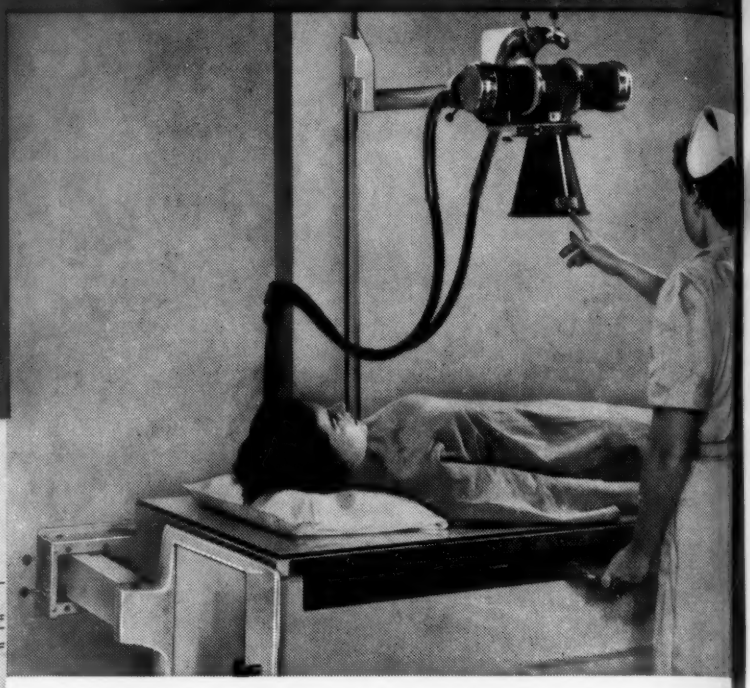

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THE AMERICAN JOURNAL OF ROENTGENOLOGY
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VOL. 74 AUGUST, 1955 No. 2

EXTRALUMINAL LOCALIZED GAS VESICLES

AN AID IN THE DIAGNOSIS OF ABDOMINAL ABSCESSES FROM THE PLAIN ROENTGENOGRAMS*

By W. WAYNE SANDS, M.D.†
Department of Radiology, Veterans Administration Hospital
DES MOINES, IOWA

UNNOTICED and undervalued are many signs hiding in the shadows of the plain abdominal roentgenogram. Overlooked, particularly, are localized, extraluminal, spherical areas of decreased density which represent gas within abdominal abscesses. These areas are frequently the only roentgenologic evidence of an abscess and often determine its exact site. Such information may influence the method of treatment and the placement of incisions.

The sign is of value in the recognition of the following abscesses:

A. *Retroperitoneal* (Table I—Cases I–VII; Table II—Cases I, II, IV, V, VI, XI, and XII)
   1. Appendiceal (Table I—Cases I–IV; Table II–Cases XI and XII)
   2. Perirenal (Table I—Cases V–VII; Table II—Cases I and II)
   3. Psoas (Table II—Case V)
   4. Pancreatic
B. *Intraperitoneal* (Table I—Cases VIII and IX; Table II—Cases III, IX and X)
   1. Appendiceal
   2. Pericholecystic (Table I—Case VIII)
   3. Others (Table I—Case IX)
C. *Subdiaphragmatic* (Table I—Case X)
D. *Abdominal Wall* (Table II—Cases VII and VIII)

Although not included in this study, they may also aid in the diagnosis of:

E. *Infected hematomas*
F. *Hollow viscus emphysema* (emphysematous gastritis, cystitis and cholecystitis)

The purpose of this paper is to emphasize that these shadows are demonstrable and are indicative of an abdominal abscess. It includes a review of 12 cases from the literature (Table II) and 10 cases of our own in which these localized, extraluminal,

* Sponsored by the Veterans Administration Hospital, Des Moines, Iowa, and published with the approval of the Chief Medical Director. The statements and conclusions published by the author are a result of his own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

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TABLE I

AUTHOR'S CASES: GAS-CONTAINING ABSCESSES

Case	Diagnosis	Roentgen Findings	Proved†	Preoperative Diagnosis	Organism	Origin of Gas
I	Abscess, appendiceal, retroperitoneal	Single, oval, 3 cm. retrocolic bubble	OM	−	Anhemolytic strep.* *E. coli* Paracolon bacillus *A. aerogenes*	Bacteriogenic
II		Multiple, small vesicles in cluster near cecum	OM	−	*E. coli* *A. aerogenes*	
III		Multiple, small vesicles in cluster near cecum	OM	+	*Strep. faecalis*** *E. coli* *Paracolon bacillus*	
IV		Multiple, small bubbles in cluster near cecum	OM	+	*E. coli* Hem. *Staph. aureus**** Anhem. *Staph. albus*****	
V	Abscess, perirenal	Multiple, large, oval bubbles overlying liver	OM	+	*P. pyocyaneus****** Paracolon bacillus *Strep. faecalis*	Exogenous Bacteriogenic?
VI		Multiple, small, spherical vesicles in clusters, kidney region	OM	+	*Strep. faecalis* *E. coli* *Proteus vulgaris* *P. pyocyaneus*	
VII	Infection, perirenal and sinus tract	Plain films one month apart. Single cluster of small spherical gas bubbles in kidney area	OM	−	*Proteus vulgaris*	Exogenous? Bacteriogenic?
VIII	Abscess, pericholecystic	Multiple small vesicles in gallbladder region	O	+	No culture	Bacteriogenic?
IX	Abscess, intra-abdominal	Film after oral cholecystography. Single, oval, 3.0 cm. bubble, cecal region	OMA	+	Anhemolytic *Staph. aureus* Strep. pneumonia Candida colony (not albicans)	Bacteriogenic? Endogenous?
X	Abscess, subdiaphragmatic	Multiloculated, huge gas collection above liver	OMA	+	Hem. *Staph. aureus* Candida colony (not albicans)	Bacteriogenic

* Anhemolytic streptococcus
** *Streptococcus encapsulatus faecalis*
*** Hemolytic *Staphylococcus aureus*
**** Anhemolytic *staphylococcus albus*
***** *Pseudomonas pyocyaneus*
† O—Operation
M—Microscopic
A—Autopsy

spherical areas of decreased density were of diagnostic value (Table I). The material included in this study was obtained from the roentgenograms of patients admitted during the last six years (1945–1950) who were known to have abscesses.

These shadows are due to bacteriogenic, exogenous, or endogenous gas collections within localized abdominal abscesses or the soft tissues. (The terms "bacteriogenic," "exogenous," and "endogenous" are defined below.) Bacteriogenic gas formations due to *Clostridium welchii* are not discussed. Endogenous gas, due to a ruptured viscus, is not considered at length.

CLASSIFICATION AND ORIGIN OF EXTRALUMINAL LOCALIZED GAS

Gas within the abdominal cavity or the soft tissues of the abdomen is classified

TABLE II

REVIEW OF LITERATURE: GAS-CONTAINING ABSCESSES

Author	Case	Diagnosis	Preoperative Diagnosis	Plain Film Findings	Organism
Watkins[6]	I	Abscess, kidney region	+	Large gas shadow, loin	*Staphylococcus albus;* hemolytic streptococci
Kindall[2]	II	Abscess, perirenal	+?	Large, multiple gas bubbles, right flank	Friedländer's bacillus
Weens[7]	III*	Abscess, intraperitoneal	+	Extraluminal gas, subhepatic area	Anaerobic streptococci
	IV	Infection, retroperitoneal	+	Gas in soft tissues, hip joint and psoas sheath	*E. coli*
	V	Infection, retroperitoneal	+	Large gas bubbles in psoas, laterocolic and thigh areas	*B. proteus*
	VI	Infection, retroperitoneal	+	Multiple, small gas bubbles in retroperitoneal mass	*E. coli*
	VII	Abscess, abdominal wall	+	Large gas collection in abdominal wall	Anaerobic streptococci
	VIII	Abscess, abdominal wall and intra-abdominal	+	Small gas vesicles	No culture
Richman[4]	IX	Abscess, intra-abdominal		Large oval gas bubble with fluid level. Small clusters	No culture
	X	Abscess, intra-abdominal		Large gas bubble with fluid level	No culture
Bird, Fissel and Young[1]	XI	Abscess, retroperitoneal, lumbar	+	Multiple gas collections retrocolic; stereoscopic views	Coliform bacilli; anaerobic anhemolytic streptococci
	XII†	Abscess, appendiceal, retroperitoneal	−	Multiple, small bubbles, right abdomen	

* Case III—Barium enema and small intestinal study.
† Operated upon because of shadows indicative of a retroperitoneal abscess.

as intraluminal or extraluminal. The origin and significance of intraluminal gas (within intestine or stomach) is beyond the scope of this paper. The origin of extraluminal gas (outside intestine and stomach) is of interest. It has been classified by Nichols and Hinkel[3] as follows:

1. Exogenous: Outside air which enters the body through a sinus tract, through a surgical incision, or at the site of skin-penetrating trauma.
2. Endogenous: Gas which escapes from a hollow viscus.
3. Bacteriogenic: Gas which results from a

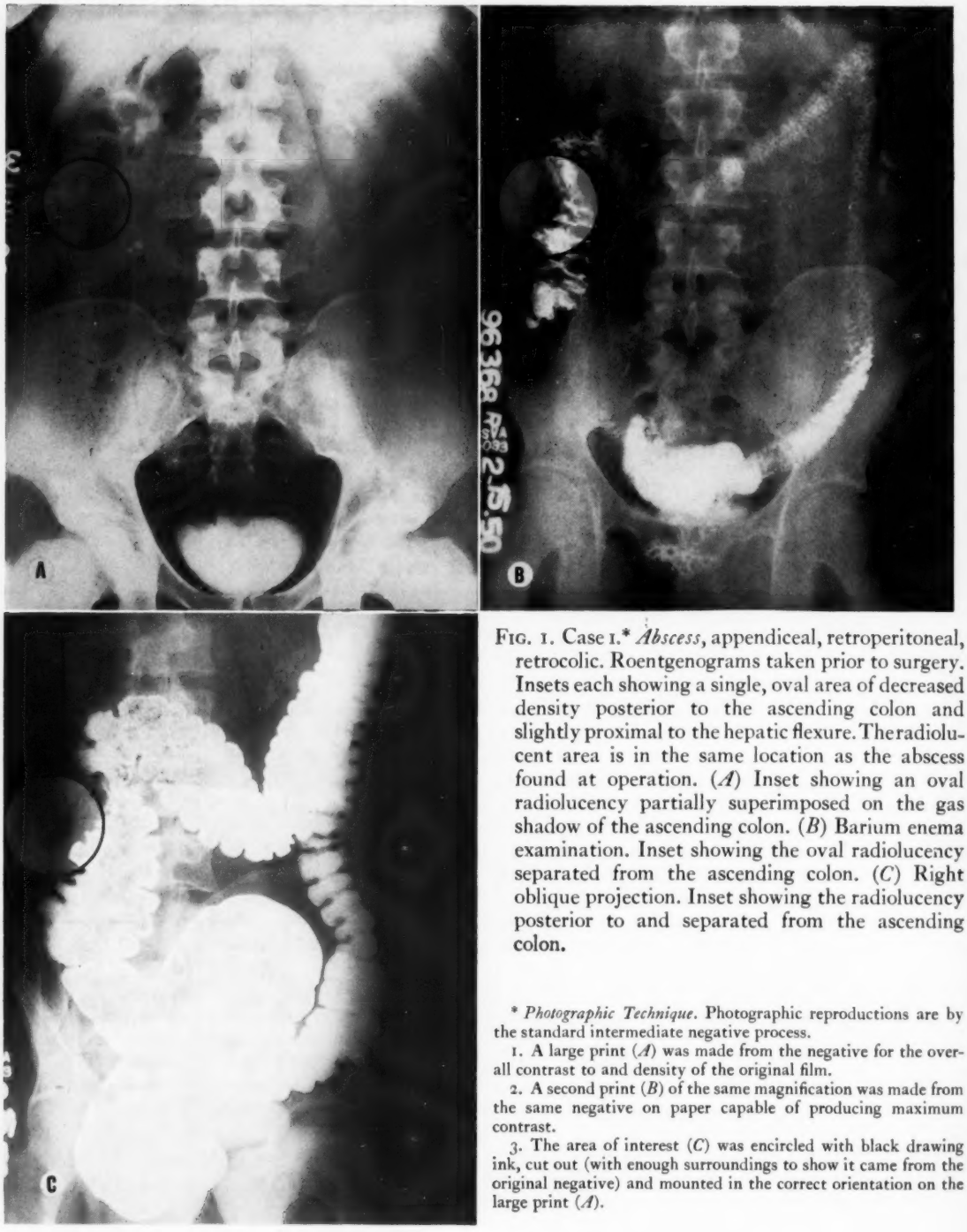

FIG. 1. Case 1.* *Abscess*, appendiceal, retroperitoneal, retrocolic. Roentgenograms taken prior to surgery. Insets each showing a single, oval area of decreased density posterior to the ascending colon and slightly proximal to the hepatic flexure. The radiolucent area is in the same location as the abscess found at operation. (*A*) Inset showing an oval radiolucency partially superimposed on the gas shadow of the ascending colon. (*B*) Barium enema examination. Inset showing the oval radiolucency separated from the ascending colon. (*C*) Right oblique projection. Inset showing the radiolucency posterior to and separated from the ascending colon.

* *Photographic Technique.* Photographic reproductions are by the standard intermediate negative process.

1. A large print (*A*) was made from the negative for the overall contrast to and density of the original film.

2. A second print (*B*) of the same magnification was made from the same negative on paper capable of producing maximum contrast.

3. The area of interest (*C*) was encircled with black drawing ink, cut out (with enough surroundings to show it came from the original negative) and mounted in the correct orientation on the large print (*A*).

> breakdown of devitalized tissue by the action of bacteria. . . .

Bacteriogenic gas is formed by numerous microorganisms. It is well known that members of the group of spore-bearing, gram-positive Clostridia may form roentgenographically visible gas. It is not so widely recognized that many common organisms may also do this. Weens[7] has reviewed the literature and found that *E.*

Fig. 2. Case II. *Abscess*, appendiceal, retroperitoneal. Roentgenograms taken prior to surgery. Inset showing multiple, spherical areas of decreased density medial to the barium-filled cecum. The radiolucent areas are in the same location as the abscess found at operation.

coli, *B. proteus* and anaerobic streptococci may form gas in human tissues. Demonstrations, in vitro, by Nichols and Hinkel[3] have shown that a variety of common organisms may produce gas in sterile citrated human blood, and they postulated that mixed infections will form gas in vivo, whereas pure cultures of the organism will not do so in vitro.

CHARACTERISTIC APPEARANCE OF EXTRALUMINAL GAS

The usual roentgenographic appearance of endogenous gas is well appreciated. It usually exists free in the peritoneal cavity conforming in shape and position to anatomic boundaries. It is often seen in the upright position as a thin dark crescent beneath the hemidiaphragm. Exogenous gas commonly collects in tissue planes and appears on the roentgenogram as dark linear striations. Bacteriogenic gas is usually formed in very small quantities and is not seen roentgenographically unless it is localized by infected tissue.

Gas, whether endogenous, exogenous, or bacteriogenic, when trapped in a localized abscess, forms bubbles which give a characteristic appearance on the roentgenogram. They appear as smoothly outlined extraluminal areas of decreased density. They are often multiple and spherical (graphically described as clusters) (Fig. 2, 3, 5 and 6), or single, oval, and large (Fig. 1, 7 and 8). Serial roentgenograms may show the vesicles to coalesce and become larger. These gas bubbles, unlike intraluminal gas, with which they are often confused on the plain roentgenograms, have a smooth globular shape, lack intestinal markings, may contain fluid levels, and remain consistent in position (Fig. 1*A*, 6*A* and 6*B*). Frequently they may be seen distinctly separated from gas-filled intestinal loops (Fig. 4*A*), or well outside the anatomic

Fig. 3. Case III. *Abscess*, appendiceal, retroperitoneal. Roentgenogram taken prior to surgery. Inset showing a single cluster of small, spherical, radiolucent areas in the cecal region.

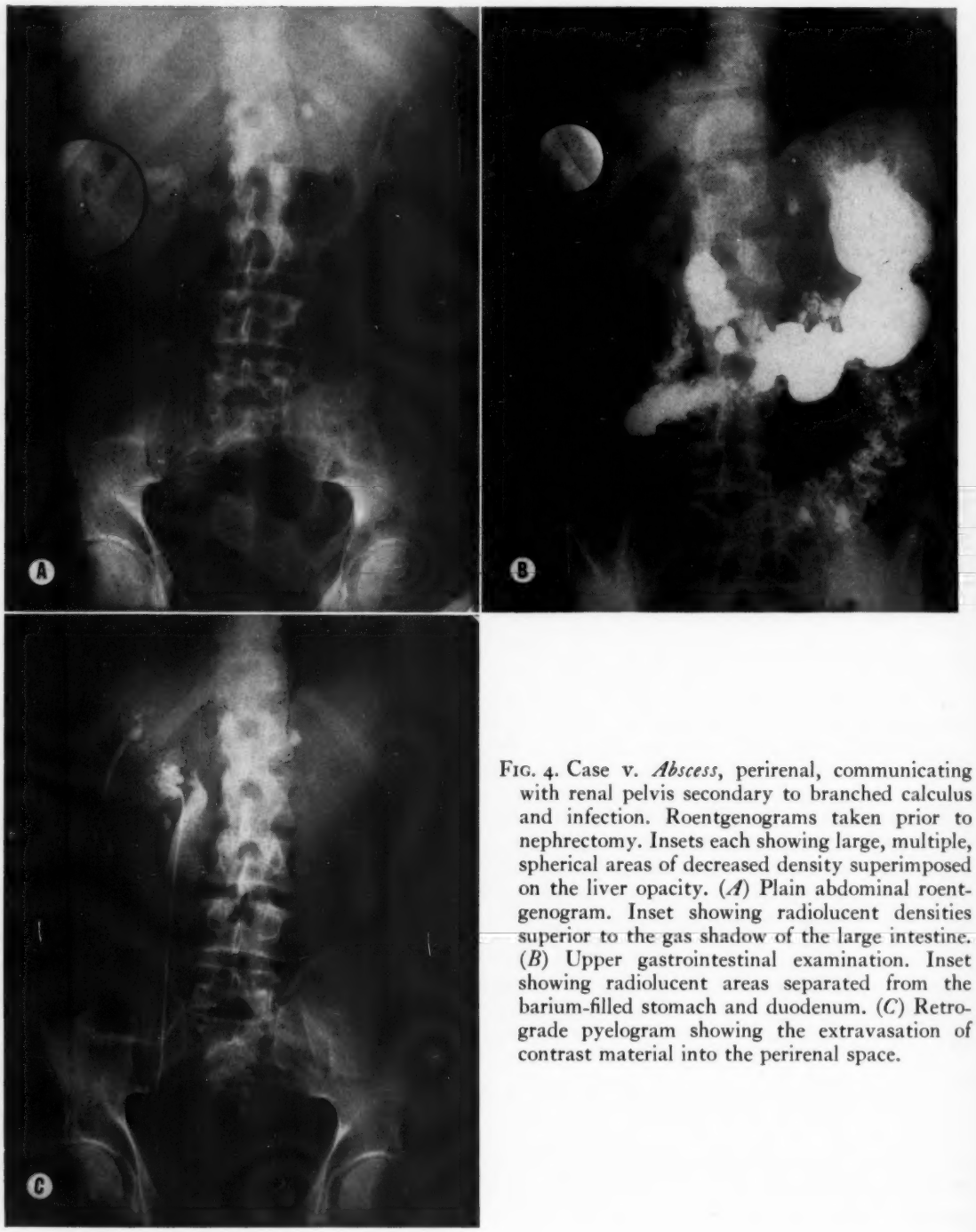

FIG. 4. Case v. *Abscess*, perirenal, communicating with renal pelvis secondary to branched calculus and infection. Roentgenograms taken prior to nephrectomy. Insets each showing large, multiple, spherical areas of decreased density superimposed on the liver opacity. (*A*) Plain abdominal roentgenogram. Inset showing radiolucent densities superior to the gas shadow of the large intestine. (*B*) Upper gastrointestinal examination. Inset showing radiolucent areas separated from the barium-filled stomach and duodenum. (*C*) Retrograde pyelogram showing the extravasation of contrast material into the perirenal space.

position of the intestine (Fig. 8). In order to determine their extraluminal position contrast studies with barium and oblique or stereoscopic views may be necessary.

REVIEW OF THE LITERATURE

Little has been written concerning the roentgenologic significance of extraluminal gas collections within abdominal abscesses

due to organisms other than *Clostridium welchii*. Weens[7] reviewed the literature up to 1946. He found Laurel had reported in 1926 that abscesses may contain roentgenographically visible gas vesicles, but this finding had been put to little diagnostic use. Gas collections due to *E. coli* and anaerobic streptococci were reported as oddities. Weens did not mention 2 cases of perirenal gas-producing infections reported prior to 1946. One of these was reported by Watkins[6] in 1936 and the other by Kindall[2] in 1941. Rigler[5] has pointed out that radiolucent areas on the plain roentgenogram may be indicative of gas in an abdominal abscess.

Weens[7] in 1946 reported 6 cases of gas-containing abdominal abscesses which were diagnosed preoperatively from the plain roentgenograms. Since 1946 four more cases have been reported. Bird, Fissel and Young,[1] in 1948, noted 2 cases of retroperitoneal abscess and believed the gas formation in these to be pathognomonic. Richman,[4] also in 1948, reported 2 abdominal abscesses with gas collections.

FIG. 5. Case VI. *Abscess*, perirenal, left, secondary to the exploration of a subdiaphragmatic abscess and fracture of left kidney. Roentgenogram taken following surgery and intravenous urography. Inset showing clusters of small, spherical, radiolucent areas in the left kidney region. Note the opaque drainage tube and extravasation of contrast substance into the perirenal space.

DISCUSSION

Extraluminal areas of decreased density on the plain roengenograms of the abdomen may represent a localized gas-containing abscess. The gas collections, whether bacteriogenic, exogenous, or endogenous, have a similar and characteristic roentgenographic appearance. Contrast studies and oblique and stereoscopic views may aid in determining their extraluminal nature.

The frequency of this finding is stressed. Seven of our 10 cases were seen within a period of one year (1949–1950). A number of cases in which the presence of extraluminal bacteriogenic gas was strongly suspected were rejected for presentation because operative proof was lacking.

It is also believed that small gas collections are commonly overlooked or mistaken for intraluminal gas shadows. This opinion would be substantiated by the reports in the literature and our own cases. Prior to 1946 only 2 cases of gas-containing abscesses had been noted. Since then, 10 cases, some containing only small quantities of gas, have been reported. Roentgenograms from 3 of our own cases, although not diagnosed preoperatively, showed characteristic findings (Table 1—Cases I, II and VII). In retrospect, Case I (Table 1—Fig. 1*B* and 1*C*) clearly showed a radiolucent density outside the barium-filled colon.

The recognition of extraluminal localized gas collections by radiologists may be more common than the literature would indicate. Photographic reproduction is tedious, and the presence of gas at operation or postmortem examination difficult to prove.*

* I am indebted to the members of the Medical Illustrations Laboratory who reproduced these roentgenograms.

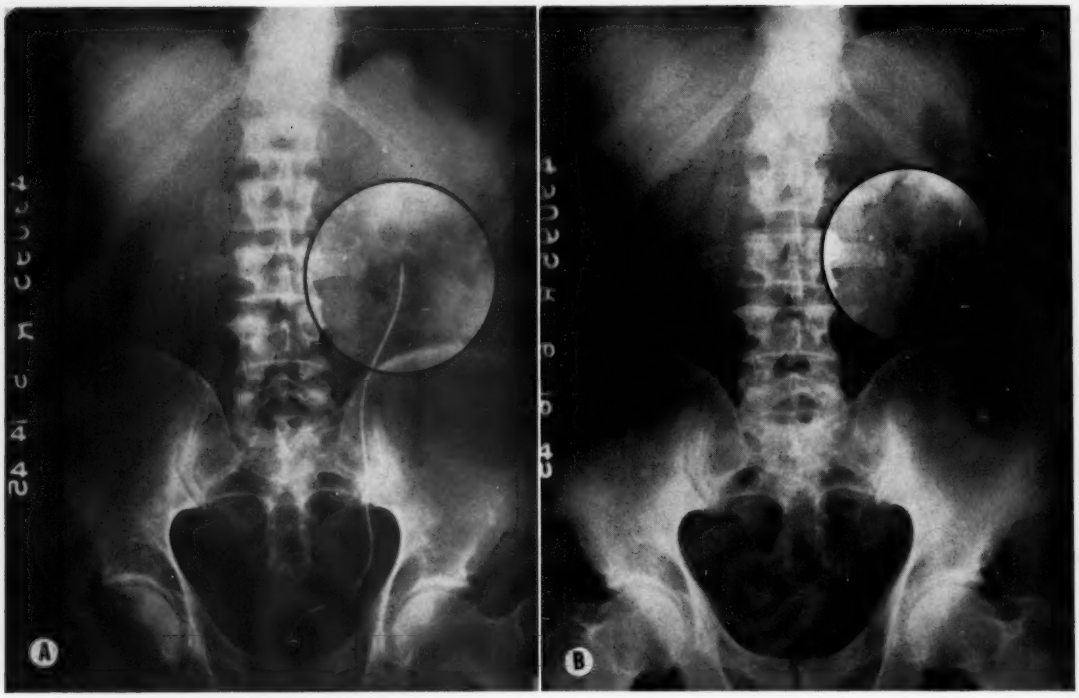

FIG. 6. Case VII. *Infection*, perirenal, left, and infected sinus tract secondary to nephrostomy. Roentgenograms taken prior to sinus tract excision. Insets each showing multiple, small, spherical areas of decreased density in the region of the left kidney. (*A*) Plain abdominal roentgenogram taken on May 14, 1945. Inset showing radiolucent areas in left kidney region. (*B*) Roentgenogram taken on June 16, 1945. Inset showing radiolucent densities similar in appearance and location to those in Figure 6*A*.

For the recognition of these shadows the plain roentgenograms are usually sufficient. In 7 of our cases, diagnosed preoperatively, contrast studies were of no diagnostic aid or not employed in 4 (Table I—Cases III, IV, VIII and X), and were of slight value only in 3 cases (Table I—Cases V, VI and IX). In all of our cases contrast studies would not have been necessary in order to make a diagnosis of a gas-containing abscess.

It is not believed that these areas are pathognomonic of a retroperitoneal infection. Cases VIII and IX (Table I) and Cases III, VII, VIII, IX and X (Table II) were

FIG. 7. Case IX. *Abscess*, intra-abdominal, pericecal, communicating with ileum and duodenum. Secondary to undifferentiated carcinoma of duodenum. Roentgenogram taken prior to exploration and following oral cholecystography. Inset showing a single, large, oval area of decreased density below the right kidney opacity. Note the extravasation of contrast medium into the abscess cavity.

Fig. 8. Case x. *Abscess*, subdiaphragmatic, right. Roentgenogram showing large multiloculated area of decreased density superior to the liver. Note that the gas outlines the shaggy wall of the abscess.

localized intra-abdominal and/or abdominal wall abscesses. Any localizing structure such as the wall of an abscess or the retroperitoneum may allow minute quantities of gas to accumulate and thus become visible on the roentgenogram. It is probable that gas formation occurs in many infections, but is not demonstrable because it escapes and diffuses into the peritoneal cavity.

CONCLUSIONS

1. Extraluminal, smoothly outlined, spherical, or oval areas of decreased density on the plain roentgenograms of the abdomen may represent localized gas within an abscess. These are commonly unnoticed or mistaken for intraluminal gas shadows.

2. They may frequently be the only roentgenologic evidence of an abscess site. Correct interpretation may influence the method of treatment.

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EFFECT OF 2 MILLION VOLT ROENTGEN THERAPY ON VARIOUS MALIGNANT LESIONS OF THE UPPER ABDOMEN*

By RUTH J. GUTTMANN, M.D.

From the Francis Delafield Hospital, Columbia Presbyterian Medical Center

NEW YORK, NEW YORK

THIS is a brief report on 40 patients who were treated with 2 million volt roentgen therapy for various malignant lesions of the upper abdomen at the Francis Delafield Hospital, New York City, between August, 1951, and October, 1953.

Before evaluating the results which were achieved in these patients, I would like to emphasize two facts: (1) we do not claim that we have increased the life span in these patients; (2) it is obvious that we cannot show any five year survivals.

All we can do then, is to report on these patients, show how we have treated them, how they have tolerated therapy and evaluate the preliminary results.

The group of patients treated is shown in Table 1. All these patients had symptoms when they were referred for radiotherapy. In all of them the disease was in a far advanced stage locally, and in most cases also generally. In the foreground of complaints were: loss of appetite, nausea and vomiting, weight loss, lack of energy and strength. Many patients had a mass in the upper abdomen which had grown rapidly; there was pain, jaundice and ascites. With the exception of the group of patients suffering from metastatic carcinoma of the liver, all these patients had an exploratory laparotomy and the disease was proved to be inoperable. In all patients the diagnosis was verified by biopsy.

TABLE I

Diagnosis	No. of Patients
Carcinoma of liver	19
Hepatoma	2
Carcinoma of stomach	6
Reticulum cell sarcoma	3
Fibrosarcoma	2
Carcinoma of common duct	2
Carcinoma of duodenum	1
Metastatic carcinoma in lymph nodes from primary carcinoma in cecum	1
Metastatic carcinoma in lymph nodes from primary carcinoma in kidney	1
Mesothelioma	1
Lymphosarcoma	1
Liposarcoma	1
	40

These patients were accepted for radiotherapy with two thoughts in mind: We wanted to see (1) how well patients would tolerate intensive therapy given through large fields directed over the upper abdomen, and (2) what we might be able to do for this group of patients with far advanced disease.

The patients who are discussed here were all treated in the same way with the 2 million volt unit with a filtration of 4 mm. of lead, equivalent to a half-value layer of 6.8 mm. of lead, and at a target-skin distance of 100 cm.

In outlining these patients for therapy we have used the following method: Contours were taken from the patient's abdomen, right over the center of the lesion and traced on paper (Fig. 1 and 2). The tumor area was drawn on the diagram together with related organs after the tumor had been localized by examination and films. The field size was then determined and the tumor dose was figured out properly. Before we started with radiotherapy, localization films were taken, in order to see that the size of the fields covered the areas which we wanted to treat. The fields had

* Presented at the Thirty-sixth Annual Meeting, American Radium Society, Hot Springs, Va., March 14–16, 1954.

Fig. 1

to be large in all these patients in order to include the entire disease area. The average size of the fields was 15 by 15 cm.; often, however, it was 15 by 20 cm., or even larger; the smallest field ever used was 10 by 10 cm., and this only in one patient.

The dose distribution of the 2 million volt unit has permitted us to deliver a sufficient tumor dose through two opposing fields. It gave us 120 r at the center of the abdomen, 13 cm. from the surface, when 100 r in air was given to each field, with very little loss of dosage at the lateral margins of the fields. The dose on the skin was 139 r (Fig. 3).

In the beginning of this series we treated

Fig. 2

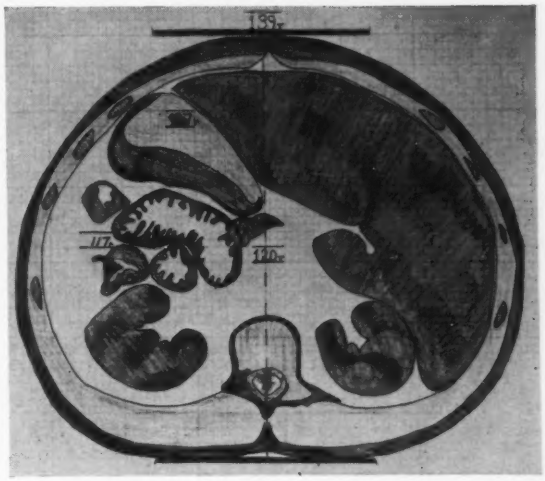

Fig. 3

3 patients with a single tumor dose of 400 r for a total tumor dose of 2,400 r, delivered in eight elapsed days. The majority of the patients, however, were treated with a daily tumor dose of 200 r and a total tumor dose of 4,000 to 4,500 r in four or four and a half weeks. The volume dose was large in these patients, who had to be treated through large fields. However, it was smaller than if we had been forced to use the conventional therapy machines.

In discussing tolerance to therapy we have to differentiate between local and general tolerance, each one immediately following therapy, and at a later date. As for immediate local reactions, the erythema and tanning following a total tumor dose of 4,000 r, which equals a skin dose of 4,655 r, were slight. The general tolerance to therapy with the described dosage has been mostly good. As far as nausea and vomiting are concerned, one has to understand that it is difficult to evaluate the after effects of the treatment on patients who in a high percentage were very ill at the beginning of therapy, some constantly nauseated and some in the last stages of their disease, but careful follow-up notes have shown that 75 per cent of all the patients did not show any changes. We have not observed diarrhea in these patients as a sequence to radiotherapy and have not seen significant changes in the blood count. So far, there

Table II

CARCINOMA OF LIVER

Total number of patients	21
Died during therapy	6
Number of patients for evaluation	15
No improvement	4
Improvement of pain	11
Shrinkage of mass	6
Duration of improvement	2 to 12 months
Death	2 to 17 months

have been no late changes in this group. In all of the patients the skin and underlying tissues have remained soft and pliable and there has not been any demonstrable fibrosis. There have not been late complications from neighboring organs up to now. Of course I am fully aware of the fact that the time has been short and that the number of patients who have lived up to two and a half years is small.

In evaluating results I am going to discuss each group separately and I shall begin with the largest group, namely carcinoma of the liver (Table II).

We have treated 19 patients with carcinoma of the liver, metastatic or primary, and 2 patients with hepatoma. The metastatic lesions were from primary carcinoma of the breast, rectosigmoid, colon, lung and adrenals. The 2 patients with hepatoma and 4 patients with metastatic carcinoma of the liver were in terminal stages of the disease and died during the treatment. Of the remaining 15 patients 4 did not benefit from 2 million volt therapy. The other 11 patients showed improvement of their main complaints—pain and pressure symptoms caused by the large mass—and this improvement lasted from two months to one year. None of the 15 patients survived more than one year and five months after completion of therapy; the earliest death occurred two months after the completion of treatment. Efforts to find in this small group a relationship between the nature of the primary lesion and the response to radiotherapy were unsuccessful; we have not found the answer.

Briefly, I would like to mention one patient and her course, because she represents a rather typical example of a patient who has improved under radiotherapy.

The patient was admitted to Delafield Hospital with large metastatic carcinoma of the liver, proved by biopsy, which occurred thirteen years after a radical mastectomy. Her main complaint consisted of severe abdominal pain and a large mass in the abdomen. At examination the liver was found to reach down to the iliac crest and way over into the left abdomen. We had to treat this patient through two adjoining fields which measured 40 by 15 cm. combined. The result of the therapy was striking. The liver shrank and the pain subsided after three treatments. The patient, who had been bedridden, was able to leave the hospital after completion of treatment, go on with her household duties and to live a normal life. This excellent result lasted for four months. Then the patient started to complain of pain in the upper abdomen again, though the liver did not show any increase in size. It was just 4 cm. below the costal margin, as it had been at the completion of radiotherapy. A second shorter cycle of radiotherapy again resulted in pain relief for another three months.

The patient died nine months after beginning of radiotherapy. The pathologist's report read: "The liver is just 4 cm. below the costal margin. Microscopic examination shows necrotic changes of many of the tumor masses, while some of the tumor appears unaffected. The liver shows typical radiation changes."

Six patients with carcinoma of the stomach were treated (Table III). One patient died during therapy; 1 patient did not improve and died six weeks after completion of therapy; 1 patient improved for a short time and gained 10 pounds, but died from generalized metastases one month after completion of therapy; 1 patient did extremely well for nine months and was free of complaints. All of a sudden his course became retrogressive and he died one month later, ten months after completion of therapy. The last 2 patients are still living and show gratifying results. One was treated for a recurrent carcinoma of the stomach, nine months after surgery. His main complaints were nausea and

Table III

CARCINOMA OF STOMACH

Total number of patients	6
Died during therapy	1
Number of patients for evaluation	5
No improvement	1
Improvement	4
Duration of improvement	1 patient — 1 mo. 2 patients— 9 mo. 1 patient —11 mo.
Dead	3
Alive	1 patient— 9 mo. 1 patient—11 mo.

vomiting with increasing weakness and loss of weight which forced him to stay in bed. After completion of therapy the patient showed great improvement. Up to now he has been able to lead a normal life and to carry out his professional duties as a minister for nine months, and he is feeling well. The sixth patient is alive and well now for eleven months after completion of therapy. As she represents an unusual case I would like to discuss her case in some detail.

Fig. 4

Fig. 5

The patient, a young woman aged twenty-seven, had complained of shortness of breath and increasing fullness in her abdomen for the last seven months before admission. On admission, a huge tumor mass was found to fill the abdomen, reaching down to the iliac crest. There was ascites and pleural effusion on the right side. Gastrointestinal series showed that the stomach was displaced to the left with an indentation on its lesser curvature and posteriorly (Fig. 4, 5 and 6).

An exploratory laparotomy was performed. The surgeon found "an enormous liver, which protruded immediately through the wound, showing the entire left lobe and one-half of the right lobe entirely replaced by tumor. The tumor had extended up the falciform ligament

Fig. 6

to the peritoneum and spread laterally on the parietal peritoneum. The liver filled the entire abdomen down to the iliac crest. There was a solid firm mass in the tail and body of the pancreas involving the posterior wall of the stomach and the lesser curvature. The pelvis was free of disease. It is unknown whether the primary disease was in the pancreas with extension to the stomach and liver or in the stomach with extension to the pancreas and liver." The peritoneum of the falciform ligament was biopsied and was reported as undifferentiated carcinoma in the peritoneum and in the liver, following carcinoma of unknown origin, most likely the stomach, the second choice being pancreas.

In April, 1953, radiotherapy was started. The patient tolerated therapy extremely well. When she had reached the half way mark, the tumor mass had shrunk 50 per cent and at the end of the therapy there was no mass palpable at all, and ascites had not recurred.

A gastrointestinal series after completion of therapy did not show any abnormality in the gastrointestinal tract. The position of the stomach and duodenal bulb was normal (Fig. 7 and 8).

One month after completion of therapy the patient went back to Trinidad and reports from there say that she had gained 19 pounds, is working, has a normal blood count, normal chest film and gastrointestinal series, and that there is no mass palpable in the abdomen.

Table IV

RETICULUM CELL SARCOMA

Total number of patients	3
Improvement	3
Shrinkage of mass	3
Duration of improvement	1 patient— 9 mo. 1 patient—20 mo. 1 patient—24 mo.
Dead	1
Alive	2

The 3 patients with reticulum cell sarcoma were all treated for extremely large lesions (Table IV).

The first patient, who was treated only nine months ago, had complained of increasing weakness, increase in size of the abdomen and fever. At surgery the abdomen was filled with fluid, and diffuse disease was found, involving the peritoneum, retroperitoneal nodes, stomach and pancreas. The entire abdomen had to be treated; the patient improved immediately, the ascites did not recur and at the present time there is no palpable evidence of disease.

The second patient was operated on with the clinical diagnosis of carcinoma of the pancreas. At the time of laparotomy, a large tumor was found, which invaded the stomach, pancreas and retroperitoneal nodes. Only a biopsy was taken, the abdomen closed and patient was referred for radiotherapy. The tumor mass measured 24 by 12 by 10 cm. The patient is alive and well two years after completion of therapy.

The third patient had about the same history. He was treated for an abdominal mass, which measured 22 by 12 by 8 cm. in November, 1951. The mass regressed under therapy and the patient remained well for one year and six months. In May, 1953, the patient developed a stony hard mass in the left supraclavicular area, which responded well to treatment. In August, 1953, the patient became ill with severe pains in the pelvis and both legs. Films taken

Fig. 7

Fig. 8

showed disease in the pelvis and lumbar spine. Therapy was given again, but to no avail and the patient died one year and ten months after beginning of radiotherapy.

Autopsy did not show "any evidence of the abdominal mass" and no microscopic evidence of it was found. There was, however, disease in pelvic bones, femora and entire spine.

The 2 patients with fibrosarcoma (Table v) showed decrease of the mass, improvement of pain and their general condition, which in 1 patient lasted one year and six months. She then developed generalized metastases and died one year and eight months after radiotherapy. A biopsy which had been taken from the tumor one year after radiotherapy showed "fibrosis and radiation changes." The second patient is alive six months after therapy.

The 2 patients with carcinoma of the

Table V

FIBROSARCOMA

Total number of patients	2
Improvement	2
Shrinkage of mass	2
Duration of improvement	1 patient— 6 mo. 1 patient—18 mo.
Dead	1
Alive	1

Table VI

CARCINOMA OF COMMON DUCT AND GALLBLADDER, INVADING DUODENUM

Total number of patients	3
Improvement	3
Improvement of jaundice	2
Duration of improvement	1 patient— 6 mo. 1 patient—18 mo. 1 patient— 4 mo.
Dead	3

Table VII

Diagnosis	Improvement	Shrinkage of Mass	Duration of Improvement	Dead	Alive
Metastatic nodes from cancer of cecum	Yes		2 yr., 6 mo.		Yes
Metastatic nodes from cancer of kidney	Yes	Yes	7 mo.	Yes	
Mesothelioma	No	No		Yes	
Retroperitoneal lymphosarcoma	Yes	Yes	9 mo.		Yes
Liposarcoma	Yes	Yes	9 mo.		Yes

common duct (Table VI), one primary inoperable, the other recurring four years after surgery, had jaundice, lack of appetite and severe itching. Both showed marked decrease of jaundice and itching after treatment. The patient with the recurrent disease died six months after completion of therapy, while the other lived without complaints one year and six months after completion of therapy. After that time he was lost to observation.

The patient with carcinoma of the gallbladder and duodenum was deeply jaundiced and very uncomfortable when referred for therapy. He showed definite subjective improvement and was able to leave the hospital after the last treatment, but he died four months after beginning of therapy.

The patient whom we treated for metastatic carcinoma of the cecum (Table VII) is alive two years and six months after completion of therapy. He was referred to us for "terminal care." The patient had had surgery for carcinoma of the cecum in 1950, was re-explored for a recurrent mass in 1951 and considered to be inoperable. In our hospital another attempt was made to remove the tumor surgically. This procedure was not possible. However, the main tumor mass was removed, the residual disease and lymph nodes were implanted with silver clips for correct localization and then 2 million volt therapy was given. The patient has no complaints and no evidence of disease.

One patient with a large retroperitoneal mass from a primary carcinoma of the kidney showed excellent improvement with complete disappearance of the mass. The improvement lasted seven months. After that time the mass recurred and the patient died ten months after therapy.

One patient with mesothelioma did not improve and died three months later without any subjective or objective changes.

One patient with a large mass of retroperitoneal nodes from lymphosarcoma has done well now for nine months after completion of therapy.

An outstanding patient in this group is one who was referred for therapy of a large inoperable liposarcoma which measured 18 by 14 by 8 cm. at the beginning of therapy and which had invaded the stomach and pancreas. This patient is at present, nine months after completion of therapy, without evidence of active disease, without evidence of a palpable mass and without complaints.

SUMMARY

Forty patients have been treated for malignant lesions of the upper abdomen. Nine died either during or shortly after completion of radiotherapy. They have to be eliminated. Out of the remaining group of 31 patients, 25 have definitely improved. These patients, who had been desperately ill before treatment, have shown marked decrease or complete disappearance of their symptoms. They have been able to resume their daily duties and to live a normal life without complaints for varying time spans,

lasting from several months to more than two years.

We know that this group is small and that the time which has elapsed since this study was undertaken is short, but we believe that the results are encouraging and gratifying. And here another thought forcibly enters our considerations: A cancer hospital unfortunately has many patients suffering from advanced disease, and these conditions have taught us to think of time in a new concept. In dealing with such patients it is impossible to think always in terms of years when judging the value of a method. Improvement and comfort have to be measured in terms of weeks and months and even limited palliation wins additional importance because it can be achieved in many instances without any added discomfort to the patients as we were able to show in 75 per cent of our patients treated for malignant lesions of the upper abdomen with 2 million volt roentgen therapy.

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DISCUSSION

Dr. Milford D. Schulz, Boston, Massachusetts. It is gratifying to hear a paper which does not deal principally with end results, increased survival time rates, cures and techniques. Dr. Guttmann has called our attention to a very important part of radiotherapy and cancer management which is not very glamorous, and sometimes much neglected, but which still is perhaps the most important part of our work—doing something for the patient sick with cancer who can't get well. If you can't touch the cancer or can't see the cancer, how many of such are really curable in a significant sense by any means? Few. This doesn't mean that we can't by radiotherapy do a lot for such patients. This I think is the most important thing which Dr. Guttmann has told us.

She has reviewed for us the results of her dealing with what is ordinarily a most unrewarding group—primary and secondary malignant tumors in the upper abdomen. All of her patients will most certainly die of their disease sooner or later; but 25 of 31 improved or symptomatically relieved certainly justifies her efforts and should encourage us all not to turn from these patients too readily. Nine of her patients died during or immediately after treatment. This, of course, is inevitable when dealing with advanced malignant disease, but it does remind us that in attempting palliative therapy, we should try as best we can to recognize those patients for whom the best treatment is no treatment other than that which will provide comfort, who are better off if we don't pester them with "much science and little sense."

Particularly interesting are two groups of patients which I at least had been taught were not to be helped much by radiotherapy—those with primary and metastatic cancer in the liver and those with inoperable cancer of the stomach. Many of us have been led to believe that radiation treatment over the liver carries with it an extraordinary likelihood of radiation illness, and this perhaps has been a deterrent to more frequent and vigorous efforts at palliation when liver metastases are present. I have almost come to believe that this is a fiction, for our experience confirms Dr. Guttmann's observations that with supervoltage radiation, at least, roentgen illness is no more of a problem when the liver is included in the field of irradiation than when it is not. Our experience in treating metastases in the liver with supervoltage radiation has not been quite as hopeful as has Dr. Guttmann's, but Dr. Nickson of the Memorial Hospital in New York also reported similarly gratifying palliation.

I think we should give some thought to the fact that the liver, although it has great ability to regenerate and recover from damage, will not always bear up under all assault, and we have had at least one death from liver damage attributed to the effects of irradiation; a young man whose hemangiosarcoma of the liver did beautifully under treatment, but whose liver after the second course of treatment with about 3,000 r to the mid-plane failed because of what pathologists who did the autopsy reported as periportal necrosis attributed to the effects of radiotherapy.

At this point it might also be well to recall that the kidneys lie in the upper abdomen and that although ordinarily we think of them as being quite undamaged by radiation in therapeutic amounts, we should recall that Dr. Doub years ago, and more recently the group at Manchester, and that has also been our experience, has determined that 3,000 r or more to the

kidneys may result in radiation nephritis, which, when it includes both kidneys, can be fatal. Fortunately, this is not a regular occurrence though it is more frequent than we perhaps know, and probably has no bearing upon those for whom palliation is the principal object of concern.

Cancer of the stomach, many of us have also been taught, was not worth palliating by radiotherapy, but I believe now with availability of supervoltage radiation and with improved techniques this attitude should be re-examined. Certainly Dr. Guttmann's report of 4 benefited out of 5 would suggest this. Perhaps our threshold of acceptance of what constitutes benefit is higher than Dr. Guttmann's for I don't believe we can report quite so optimistically, but nevertheless we have treated quite a number of patients with inoperable cancer of the stomach some of whom have shown most extraordinary palliative effects. These, like Dr. Guttmann's best results, were among the younger people sick with this disease.

One group of neoplasms of the stomach in which relief by radiotherapy is the rule is lymphoma. When lymphoma is confined to the stomach, "cure" with and perhaps without the help of surgery can sometimes be effected. We now have a number of such patients living, and for all purposes well, for many years following radiotherapy even when all of the disease was not surgically removable.

One gloomy note to temper a happy report. Dr. Guttmann did not say anything about cancer of the pancreas which also lies in the upper abdomen. All such patients whom we have treated with supervoltage or other radiation who could have been counted as having been favorably affected were later shown not to have had cancer. In all instances the pathologist has recanted his diagnosis of cancer of the pancreas and said it was only chronic pancreatitis after all. I should like to hear if anyone can report favorably upon radiotherapy of cancer of the pancreas.

And now, finally, to say something about which Dr. Guttmann has passed over lightly except in the title of her paper. Is supervoltage radiation really desirable or necessary when palliation is the object in view? I don't think it is necessary, but if one intends to give 4,000 r tissue dose in the depths of the upper abdomen, as Dr. Guttmann does, and if one will bear in mind that palliation also means doing as little harm and upsetting the already sick patient as little as possible while trying to accomplish some good, then for well established physical reasons with which we are all familiar, I must say that in certain conditions it certainly helps.

Many thanks to you, Dr. Guttmann, for an honest presentation of a worrisome problem, and for your encouragement to many of our incurable patients.

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ADRENAL CORTICAL INSUFFICIENCY IN INFANTS SIMULATING HIGH INTESTINAL OBSTRUCTION*

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RECENT advances in our knowledge of the physiology of the adrenal cortex have greatly enhanced the clinical recognition of dysfunction of this endocrine organ. There are several disease entities of early childhood in which altered secretion of adrenocortical hormones seems to play an essential part.

Most infants suffering from abnormal adrenocortical function may be classified into three groups on the basis of clinical observation.[3] (1) Patients in whom deficient secretion of the hormone regulating water and salt metabolism induces severe temporary or permanent electrolyte disturbances. (2) Instances of adrenal hyperplasia with excessive liberation of adrenal androgens. Female infants in this group manifest pseudohermaphrodism, due to the virilizing influence of these hormones on the development of the female genital tract. Male infants have normal external genitalia at birth, but subsequently show signs of premature sexual maturation. (3) Patients in whom the combination of the clinical features of the first two groups becomes apparent.

The electrolyte disturbances manifested by the patients of the first and third groups may result in advanced dehydration and severe gastrointestinal disturbances, particularly vomiting and diarrhea.[4,5,13] The vomiting of these infants may be projectile in character and so pronounced that it often predominates the entire clinical picture. Adrenal insufficiency is thus likely to simulate the presence of high gastrointestinal obstruction, such as hypertrophic pyloric stenosis, for which it has frequently been mistaken.

We wish to emphasize that the differentiation of adrenal cortical insufficiency from high intestinal obstruction may be difficult not only on clinical but also on roentgenologic examination. In the following 2 cases of adrenal cortical insufficiency the roentgen findings showed striking resemblance to hypertrophic pyloric stenosis and to duodenal obstruction.

REPORT OF CASES

CASE 1. B.B.R., a white male infant, was born at Grady Memorial Hospital on July 25, 1952, with a birth weight of 8 lb., 10 oz. His mother's pregnancy and delivery had not been remarkable. On the third day of life, he began regurgitating brown mucoid material, and two days later he developed persistent projectile vomiting. There were no respiratory difficulties. Roentgenoscopic examination of the esophagus with lipiodol one week after birth did not demonstrate obstruction. There was, however, anterior displacement of the proximal esophagus consistent with an anomaly of the aorta, such as a double aortic arch. The trachea was also outlined with lipiodol and not found to be encroached upon. The vomiting persisted and the vomitus was bile stained. On one occasion it contained gross blood. Stool examination, urinalysis, red blood cell count and hemoglobin were not remarkable.

A gastrointestinal series performed at the age of two weeks demonstrated a narrowing of the entire prepyloric and pyloric segment of the stomach (Fig. 1 and 2). The barium in this region formed a thin streak and the base of the duodenal cap showed a slight indentation. In spite of this obstruction, in follow-up studies fairly satisfactory filling of the duodenum and proximal small intestine could be demonstrated. Another gastrointestinal series three weeks after birth confirmed the previous findings. During the entire time the patient had been on antispasmodic therapy. The serum sodium was 104 mEq. per liter and the serum potassium was 2.85 mEq. per liter three weeks after birth.

An exploratory laparotomy was performed

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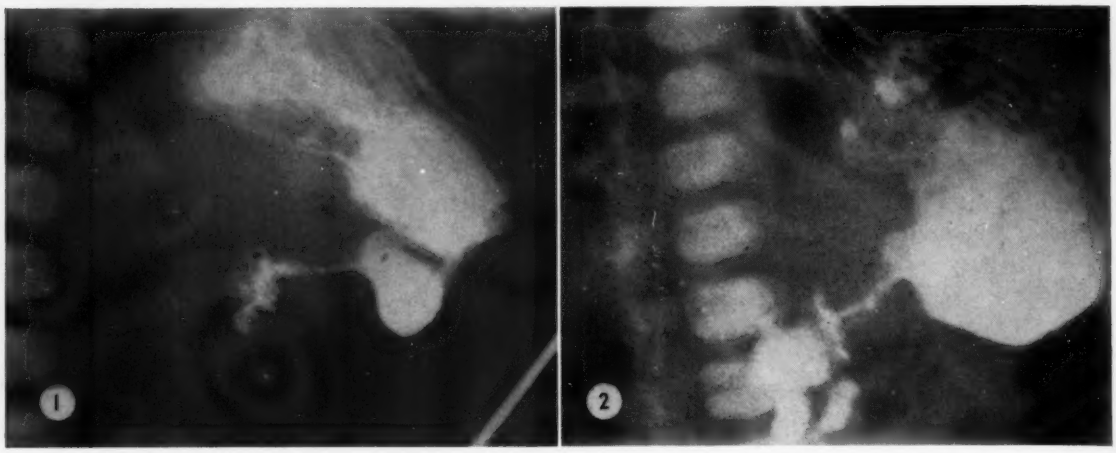

FIG. 1 and 2. Serial roentgenograms demonstrating persistent narrowing of prepyloric and pyloric segments of stomach, resembling hypertrophic pyloric stenosis.

on the thirtieth hospital day. The operation revealed an annular pancreas about the second portion of the duodenum. There did not appear, however, to be any significant obstruction. The pylorus was normal. An anterior gastrojejunostomy was performed.

Vomiting persisted postoperatively. Roentgenologic studies showed a functioning gastrojejunostomy. The operative wound separated and thrombophlebitis appeared at several cut down sites. The infant was again explored on the forty-fourth hospital day. A jejunal herniation into a rent in the mesentery was found and repaired. There was no postoperative improvement and vomiting persisted despite all attempts to correct his fluid and electrolyte imbalances. Subcutaneous abscesses appeared and purpuric spots were noted over the trunk. The patient died on the fifty-third hospital day.

Postmortem Examination. The complete continuity of the gastrointestinal tract was readily demonstrated. No obstructive lesions were found. The peritoneal cavity showed a subsiding peritonitis. An annular pancreas was found which resulted in only minimal narrowing of the lumen of the duodenum. Examination of the cardiovascular system revealed a persistent fourth left posterior aortic arch, patent foramen ovale and ductus arteriosus. The lungs displayed multiple infarcts, congestion, edema and a terminal aspiration pneumonitis.

The adrenal glands had a combined weight of 7.5 gm. Both glands were unusually firm to palpation. The cortices were thin and pale. The right adrenal medulla appeared hemorrhagic with areas of necrosis. Histopathologic examination showed extensive replacement of the cortices by moderately dense, fibrous connective tissue. Many necrotic cortical cells were present and often only ghost-like outlines could be discerned. Extensive deposition of calcium salts was seen in these necrotic areas. In a few areas, islands of cells with the configuration of the zona glomerulosa were seen as well as a few nodules of distinct cortical hyperplasia. Many pigment laden macrophages were scattered throughout the glands. The medullary areas were completely replaced by dense, fibrous connective tissue. Reticulum preparations revealed remarkable preservation of the cortical and medullary reticulum pattern (Fig. 3).

Comment. This male infant developed persistent vomiting on the third day of life. Roentgenologic examination showed changes consistent with hypertrophic pyloric stenosis but exploratory laparotomy did not reveal any obstructive lesions. The infant's course remained unaltered, death occurring on the fifty-third day of life. At autopsy, there were congenital cardiovascular anomalies, an annular pancreas that produced only minimal compression of the duodenum, and extensive destruction of the adrenal glands. The replacement of the major portion of the adrenal cortices by dense connective tissue and the presence of marked calcification indicated the damage to be of considerable standing, dating quite possibly to the first few days of life.

Fig. 3. Adrenal cortex from Case 1. The uppermost pale area consists of dense fibrous tissue. Beneath this is a dark staining thin layer that represents the little remaining adrenal cortical glandular tissue. Below is another area of fibrosis, and the lower half of the microphotograph shows necrotic tissue. Phloxine and hematoxylin ×100.

Case II. S.D.W., a nine day old white female infant, was admitted to Henrietta Egleston Hospital on August 11, 1949, because of persistent vomiting since birth. The vomiting was described as forceful, but not definitely projectile. The parents stated that there had been daily bowel movements of normal appearance. Delivery had been uneventful and the birth weight had been 5 lb., 13 oz. The child's mother received weekly parenteral estrogen therapy throughout pregnancy, the last injection being administered the day before delivery. There were 5 siblings living and well.

On admission, the child weighed 3 lb., 12 oz. and appeared thin and dehydrated. The temperature was 103° F. The heart and lungs were normal. The liver was palpated 6 cm. below the costal margin. The external genitalia and anus were unremarkable.

The urine specific gravity was 1.012. The white blood cell count was 16,200 per cu. mm. with 76 per cent polymorphonuclear leukocytes. The blood hemoglobin concentration was 20 gm. per cent and the red blood cell count was 5.6 million per cu. mm. The feces contained a trace of bile and were negative for occult blood.

A survey film of the abdomen obtained on the second hospital day disclosed distention of the stomach and duodenal cap with air (Fig. 4). There were no intestinal gas shadows distal to these structures. The presence of duodenal obstruction was suspected, and, for confirmation of this diagnosis, barium was introduced into the stomach. The contrast medium passed into the proximal duodenum but no filling of the second portion of the duodenum could be observed (Fig. 5).

An exploratory laparotomy was performed on the third hospital day. No abnormalities of the gastrointestinal tract were encountered although the duodenum was not completely visualized. A gastrojejunostomy was performed.

There was no postoperative improvement and the child continued to vomit all oral feedings. The vomitus was bile stained. Further roentgenologic studies again revealed distention of the stomach and proximal duodenum with air. Following injection of contrast medium into the stomach a functioning stoma could not be established.

A second abdominal exploration was performed on the twelfth hospital day. There was again no evidence of organic obstruction. A tube was passed from a jejunostomy through the gastrojejunal anastomosis into the stomach. The child responded poorly following surgery

FIG. 4. Case II. Marked gaseous distention of stomach and proximal duodenum, resembling duodenal obstruction.

and died on the thirteenth hospital day—the twenty-second day of life.

Postmortem Examination. At autopsy, compete continuity of the gastrointestinal tract was demonstrated. There was no gross or histologic evidence of malformation or of obstruction. The gastrojejunostomy and the jejunostomy were intact. A 2 mm. perforation was found near the site of gastrojejunostomy and there was a generalized acute peritonitis.

The combined weight of the adrenal glands was 2.4 gm. They were normal in shape and consistency. Histopathologically, there was a marked uniform decrease in thickness of the cortex. Most of this decrease was due to a very thin, but orderly, zona fasciculata. There was only slight evidence of the presence of the zona glomerulosa. The zona reticularis was present and appeared to be undergoing normal involution. No lipoid material could be recognized in any of the cortical cells. The medulla was normal except for congestion and minimal lymphocytic and plasma cell infiltration (Fig. 6).

Other findings at autopsy were a bronchopneumonia and a small (3 mm.) cardiac interventricular septal defect.

Comment. This female infant developed persistent vomiting on the day of birth. Repeated roentgenologic examinations revealed distention of the stomach and duodenal cap such as is observed in duodenal atresia or stenosis. Two exploratory laparotomies failed to reveal an obstructive lesion. Death occurred on the twenty-second day of life. At autopsy, the entire gastrointestinal tract was normally developed and patent. The adrenal glands had a combined weight of only 2.4 gm. and showed a generalized hypoplasia of the cortex.

DISCUSSION

Addison, in his classical description of adrenal hypofunction, emphasized the marked gastric irritability exhibited by pa-

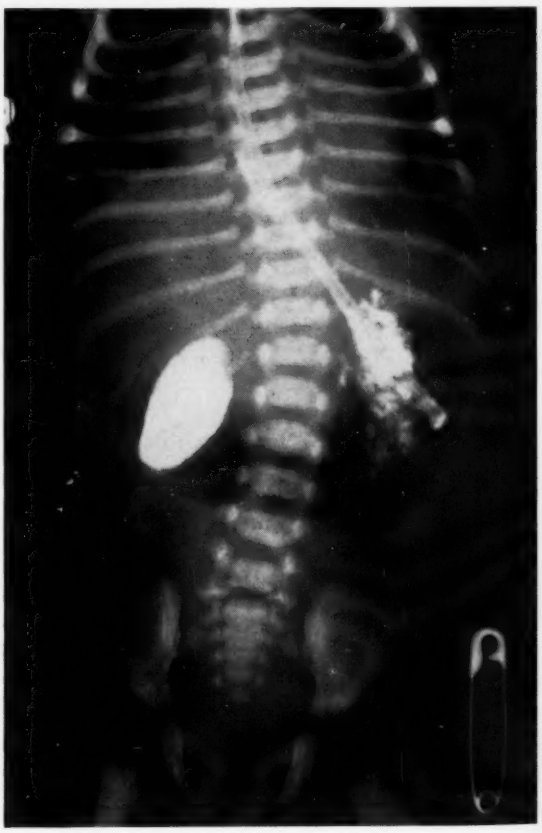

FIG. 5. Case II. Following injection of contrast medium. Apparent obstruction of duodenum.

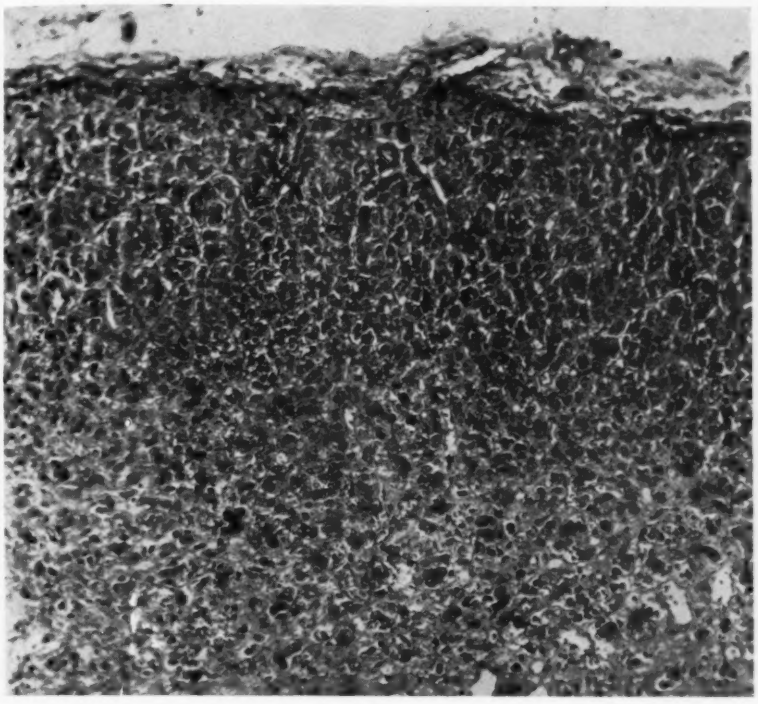

Fig. 6. Adrenal cortex from Case II. The upper half of the photomicrograph shows a poorly developed zona glomerulosa and a thin irregular zona fasciculata. The lower half shows the zona reticularis which is undergoing normal involution. Phloxine and hematoxylin ×100.

tients affected with this disorder.[1] It is generally believed that the cortical hormone regulating salt and water metabolisms affects gastrointestinal motility, although the mechanism of this action has has not been clarified.[6,7]

Infants suffering from a deficient production of this hormone manifest pronounced vomiting simulating high intestinal obstruction. The vomiting is frequently, as in hypertrophic pyloric stenosis, projectile in character. For this reason this syndrome has been designated by several authors as pseudopyloric stenosis.[4,11,14] Due to the striking resemblance to hypertrophic pyloric stenosis, it is not surprising that a rather large number of patients with adrenal insufficiency have been subjected to operation.

Deficient production of the salt and water controlling hormone in infants is encountered principally in two groups of patients. The first group comprises infants with generalized adrenal cortical hypoplasia. Our Case II may be added to the small number of autopsy reports of patients in this group.[3,5,15] The adrenal glands in these patients are considerably reduced in size, but maintain normal configuration. Histopathologically they reveal poor formation of the outer zona glomerulosa, and the zona fasciculata, which are generally believed to be concerned with electrolyte and carbohydrate metabolism (Fig. 6). The androgenic zone or zona reticularis shows normal involution. These findings are not infrequently associated with other congenital abnormalities.[15] Our Case I showed an extensive destructive process of the adrenal gland with massive replacement of the normal parenchyma by dense fibrous tissue with calcification (Fig. 3). An exact interpretation of the nature of the destructive process is impossible, but it is suggested that the observed adrenal changes represent an abnormal reaction to the physiologic postnatal involution of the inner cortex.

Less severe degrees of adrenocortical insufficiency have been postulated. Jaudon[6,7] observed a large series of electrolyte disturbances which could be alleviated and relieved by the administration of desoxycorticosterone. He emphasized that the various functions of the adrenal gland may

vary independently one from another and that in his patients the adrenal disturbances were apparently confined to lack of adequate liberation of the salt and water controlling hormone. Since all of his patients recovered, no morphologic data are available.

More commonly these electrolyte disturbances are met in a second group of patients in whom the adrenal glands are grossly hyperplastic and who show clinical signs of excessive androgenic activity.[2,16,17]

The adrenal glands are often many times normal size and have a configuration suggesting cerebral convolutions. On histopathologic examination they show an extensive hyperplastic process limited to the inner zona reticularis (androgenic zone) with an associated hypoplasia of the zona glomerulosa and zona fasciculata. Female infants affected by this disorder are born pseudohermaphrodites due to the virilizing influence of the androgenic hormone on the embryonic development of the female genital tract. Male newborns usually have normal external genitalia, but show, during the first two years of life, evidence of premature sexual maturation.

The clinical recognition of this hormone deficiency is facilitated in those infants who exhibit associated androgenic activity. In female newborns who are pseudohermaphrodites, electrolyte disturbances should be suspected and searched for. In those patients in whom the hormone disturbance is confined to the regulation of salt and water metabolism, the clinical diagnosis is more difficult, depending on proper evaluation of the gastrointestinal symptoms. It might be well to consider the possibility of adrenal cortical insufficiency in all instances of apparent high intestinal obstruction in the newborn period.

The electrolyte changes in the plasma, low sodium and chloride levels, as well as elevated potassium values, may aid considerably in establishing the correct diagnosis.[7] Of foremost importance is the observation that in these infants, despite severe vomiting, chloride elimination in the urine persists since the kidneys are apparently unable to preserve chlorides for the body. In vomiting due to organic intestinal obstruction, urinary chloride values are markedly depressed.

The roentgenologic findings in our 2 cases are most interesting. In Case 1 the roentgen signs were entirely compatible with the diagnosis of hypertrophic pyloric stenosis. The roentgenologic features of this condition have been described in detail elsewhere.[9,10,12] They consist briefly in the roentgenologic demonstration of an elongated and narrowed pyloric channel. If the pyloric channel is only partially filled, the barium column may assume a beak-like protrusion. On more complete filling of the pyloric channel, a narrow stream of barium is seen to extend from the gastric antrum towards the duodenum (string sign). In some instances indentation of the base of the duodenal cap by the pyloric tumor may be noted. The marked narrowing and elongation of the pyloric channel was present in our patient. The filling of the duodenal cap was perhaps somewhat more pronounced than usually observed in patients with hypertrophic pyloric stenosis. Since there was at autopsy no evidence of any organic lesion, we have to assume that the roentgenologic deformity of the distal stomach was due to persistent spasm.

In Case 11, the resemblance to duodenal atresia is puzzling. It has been stressed that the intestinal air pattern as shown in Figure 4 may be considered as almost pathognomonic of this condition.[8] The stomach as well as the duodenal cap in these patients is usually markedly dilated with air or fluid. The findings following administration of barium confirm these observations. Since there was at autopsy no organic obstruction demonstrated, a motility disturbance of the duodenum has to be postulated leading to dilatation of the duodenal cap and functional obstruction of the second portion of the duodenum.

It should not be expected that all cases of infantile adrenal insufficiency will reveal this roentgenologic pattern. In many in-

stances delayed gastric emptying, sometimes of a severe degree was encountered on roentgen examination.[7,13] In other reported cases, the roentgen examination of the gastrointestinal tract was not found to be abnormal.[1] The observation in our 2 cases may suffice, however, to alert pediatricians and radiologists to the difficulties in the roentgenologic differentiation of adrenal insufficiency from organic high intestinal obstruction.

SUMMARY

1. Adrenal cortical insufficiency in infants may manifest itself by severe vomiting and dehydration simulating high intestinal obstruction.

2. Two cases are described in whom the roentgenologic examination showed striking resemblance to organic high intestinal obstruction. In the first case, the roentgenologic signs of hypertrophic pyloric stenosis were demonstrated; in the second, the roentgenologic pattern of duodenal obstruction was simulated. Postmortem examination failed to reveal obstructive gastrointestinal lesions. The adrenal gland of both patients showed a marked diminution in cortical tissue. There was generalized cortical hypoplasia in one instance, and a severe destructive process in the other.

3. The difficulties of clinical and roentgenologic differential diagnosis are emphasized.

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We are indebted to Dr. M. H. Roberts for the clinical data on Case II.

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ROENTGEN EXAMINATION OF THE ABDOMEN IN ACUTE PANCREATITIS*

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IN THE "acute surgical abdomen," the diagnosis of acute pancreatitis is very important since the present treatment of this disease is conservative, while emergency laparotomy is indicated in most other abdominal crises. The author believes that a roentgen examination of the abdomen may aid in the differential diagnosis of acute pancreatitis.

In the Caldwell Lecture of 1939, Case[2] chose as his subject, "Roentgenology of Pancreatic Disease." In his discussion, he mentioned the findings of left pleural effusion in acute pancreatitis. But no mention was made of the plain film of the abdomen. Most of the studies of pancreatitis have been done with the aid of a barium-filled stomach. Bockus[1] states that, "roentgen ray study has little positive value, but the finding of no abnormality may greatly aid in the differential diagnosis of the 'acute abdomen.'" He does, however, state that if the patient shows signs of residual disability, barium studies may suggest the presence of fluid in the lesser omental sac or may show a defect in the shadow of the barium-filled stomach, small or large intestine, due to displacement from a pancreatic cyst.

However, Metheny, Roberts and Stranahan,[6] in a review of 27 proved cases, mentioned as new additional findings the fact that in a plain film of the abdomen localized gas in the stomach, duodenum and transverse colon may be seen. They did not state how much importance should be attributed to this sign.

In 1948, Paxton and Payne[7] published a review of 307 established cases. Their review was an analysis in respect to all factors entering into the problem of diagnosis and treatment. In their analysis of the roentgenologic contribution to the diagnosis, they made the following statement:

"In the later stage of the disease, the x-ray picture of the abdomen frequently shows a segmental type of ileus which may involve the stomach, small intestine, or colon. The transverse colon exhibits this phenomenon more often than the rest of the bowel. One hundred and twenty-five of three hundred and seven patients had emergency scout films of the abdomen. Eighty-two cases (86%) revealed a segmental type of ileus. This segmental distribution of gas is not pathognomonic of acute pancreatistis roentgenographically, but it certainly suggests the diagnosis."

Grollman, Goodman and Fine[5] reported 8 cases of acute pancreatitis in which a "sentinel loop" of dilated small intestine was found. Six of their 8 cases had loops of small intestine in the left upper quadrant or the mid-abdomen. They stressed the point of determining the level of serum amylase whenever this finding was present.

From May, 1946, through February, 1951, there have been forty admissions to this hospital in which the discharge diagnosis was acute pancreatitis, and which may be assumed to be clinically proven cases. Eleven of these patients have had two admissions and 1 patient has had five admissions with the same disease. Of these forty admissions, an emergency roentgen examination of the abdomen was performed nineteen times. Some of these patients have had more than one roentgen examination on the same admission. Five cases had exploratory laparotomies, 1 of which had

* From the Radiological Service, Veterans Administration Hospital, Richmond, Virginia.
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Fig. 1. Case 1. Anteroposterior roentgenogram of the abdomen; no abnormalities noted.

no demonstrable lesions at operation. This 1 case had an elevated serum amylase immediately following operation.

We present 4 cases which best demonstrate the findings under discussion.

REPORT OF CASES

Case 1. B.H., a white male, aged forty-one, was admitted January 25, 1951, with a history of the sudden onset of acute epigastric pain with nausea and vomiting about sixteen hours before admission. On admission, his abdomen was very tender throughout, with muscle guarding. Films of the abdomen were taken about eighteen hours after the onset of pain. The supine and upright films of the abdomen revealed several loops of slightly dilated small intenstine in the mid-abdomen which appeared to contain fluid levels (Fig. 1 and 2). A film taken in the left lateral decubitus position with a horizontal beam outlined the duodenal arc with air (Fig. 3). No dilatation of the large intenstine was noted. There was a fluid level in the stomach. The serum amylase, by the method of Bray, was 122 units on admission (40–50 units are top normal). This patient developed a psychosis on his third hospital day. Soon after this, he began to improve with only conservative therapy of Wangensteen drainage and intravenous fluids. In about three weeks, he was asymptomatic and back on a regular diet.

Case 11. M.H., a Negro male, aged twenty-eight, was referred to this hospital on Novemver 1, 1950, with a diagnosis of atelectasis of the left lower lobe. He had been in this hospital in 1948 with a diagnosis of alcoholic gastritis. On November 27, 1950, while in the hospital, he developed sudden, severe, left upper quadrant and left lower chest pain which was similar to his previous attacks. Roentgenograms, taken within six hours after the onset of pain, revealed the following:

Chest (Fig. 4)—No infiltrations are noted. There is elevation of the left leaf of the diaphragm with a small amount of pleural effusion obliterating the costophrenic sulcus.

Abdomen (Fig. 5)—Upright view revealed dilated loops of small intestine in the left upper quadrant. The left lateral decubitus view revealed the duodenal loop outlined by air (Fig. 6).

A serum amylase, taken on November 27, just before the patient came to the Roentgen Department, was 118 units. This patient concontinued to have intermittent attacks of similar but less severe pain. A barium study of the stomach on December 1, 1950, revealed

Fig. 2. Case 1. Upright anteroposterior roentgenogram of the abdomen; slightly dilated small intestine with fluid levels.

Fig. 3. Case I. Left lateral decubitus view; duodenal arc outlined with air.

Fig. 4. Case II. Roentgenogram of the chest shows elevation of the left diaphragm with a small amount of pleural effusion.

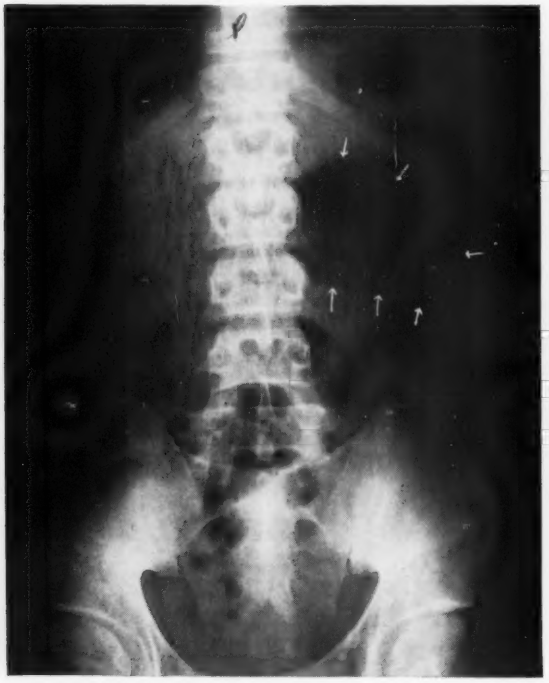

Fig. 5. Case II. Upright anteroposterior roentgenogram of the abdomen shows dilated loops of small intestine in the left upper quadrant and mid-abdomen.

Fig. 6. Case II. Left lateral decubitus view; duodenal arc outlined with air.

what was thought to be a small prepyloric ulcer. Exploratory laparotomy on December 20 revealed a normal stomach and duodenum. The pancreas was thought to contain areas which were softer than normal. A diagnosis of possible chronic pancreatitis was suggested. The patient became much better and was discharged on a dietary regimen.

Case III. L.L.H., a white male, aged twenty-five, was admitted on October 7, 1950, with a three month history of four attacks of burning epigastric pain, lasting about one hour each. About 1:00 P.M. on October 7 the patient experienced the sudden onset of acute epigastric pain with nausea and vomiting. Examination revealed epigastric tenderness with muscle guarding. The first roentgen examination, performed about six hours after the onset of pain, revealed no abnormalities in the abdomen. A second examination, performed about twenty-three hours after the onset of symptoms, revealed dilated loops of small intestine in the left upper quadrant (Fig. 7). On the left lateral decubitus film (Fig. 8), the distal portion of the stomach and the duodenal arc are outlined with air. In the upright view of the abdomen (Fig. 9), dilated loops of small intestine in the left upper quadrant are seen. In the right lower quadrant, an air-fluid level is noted which does not conform to the contour of the intestine and appears to be an extraluminal

Fig. 8. Case III. Left lateral decubitus view; duodenal arc outlined with air.

Fig. 7. Case III. Anteroposterior view of the abdomen shows dilated loops of small intestine in the left upper quadrant.

Fig. 9. Case III. Upright anteroposterior view of the abdomen shows dilated loops of small intestine in the left upper quadrant. Air-fluid level in right lower quadrant with irregular contour.

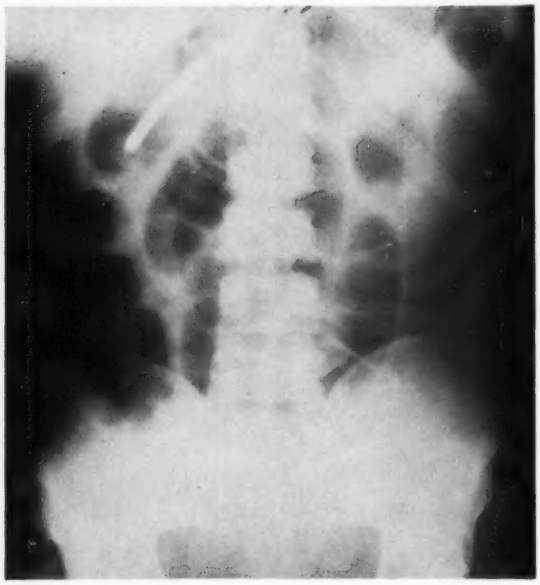

Fig. 10. Anteroposterior view of the abdomen shows the ascending and proximal transverse colon dilated. Dilated loops of small intestine in the mid-abdomen.

collection of fluid lying mesial to the cecum. This finding was also present on the original film in the supine and upright positions, but is not seen on the reproductions. Serum amylase on October 9 was 141 units.

This serum amylase was reported by telephone to be normal and an exploratory laparotomy was performed on October 10. Areas of fat necrosis were found in the omentum. The head and body of the pancreas were hemorrhagic and soft. In the right lower quadrant, there was a retroperitoneal collection of serosanguineous fluid overlying the psoas muscle. This fluid, aspirated with a syringe and needle, assayed at 336 units of amylase. The patient had a very stormy convalescence and within a few weeks developed a pancreatic cyst which was marsupialized. Eventually the drainage ceased, but in the meantime, he developed a fistula into the transverse colon. This closed spontaneously but the patient was then found to have a nonfunctioning gallbladder with a nonopaque stone. A cholecystectomy has since been performed, and at present the patient is asymptomatic.

DISCUSSION

In an analysis of our findings in 19 cases, three patterns of gas distribution were noted. In 12 cases, the ascending and transverse colon were distended and contained fluid levels. Figure 10 demonstrates dilatation of the ascending and transverse colons. Unfortunately, the lateral decubitus and upright films were not taken on this patient. In 9 cases, the stomach and duodenal arc were slightly to moderately distended and frequently contained air-fluid levels. In 10 cases, dilated loops of small intestine were seen in the midepigastrium and left upper quadrant. The combination of dilated stomach, duodenal arc, and large intestine was seen in only 3 cases. The dilated small intestine was frequently seen in conjunction with dilated stomach and duodenum.

The use of the left lateral decubitus position with a horizontal beam was of great value in 6 cases in which the duodenal loop was outlined only in this position. In 1 case, the survey roentgenogram and upright anteroposterior view showed no abnormalities while the film in lateral decubitus revealed the lower end of the stomach and duodenal arc to contain air. In 6 positive cases out of 19, the lateral decubitus film was of definite value. At this institution, this position is used in all examinations for intestinal obstruction and perforated viscus and has been found of value in many of these cases.

In reviewing the films for this discussion, I felt that the roentgen examination was highly suggestive, if not diagnostic, in 12 cases. In 7 cases, no definite diagnosis could be suggested from the roentgen findings. However, the absence of any definite findings were of value by ruling out perforation of hollow viscus or intestinal obstruction. Case III, incidentally, is the only case which demonstrates the "typical" left pleural effusion.

The differential roentgen diagnosis in these cases must include such conditions as high small intestinal obstruction or localized peritonitis in the epigastrium. One case was seen at this institution with dilatation of stomach, duodenal arc, and some loops of jejunum due to a localized sub-

diaphragmatic ileus secondary to a stab wound of the thorax. Another case was seen with a dilated duodenal loop which on exploratory laparotomy proved to be due to a suppurative appendicitis, the tip of which lay just next to the duodenum.

In respect to the length of time from the onset of the illness to the taking of the abdominal roentgenograms, positive findings were present as early as six hours and as late as four days after the onset of symptoms. Only two examinations revealed positive findings as early as twelve hours after the onset of pain. Six positive cases were examined between twelve and twenty-four hours and 5 cases between twenty-four and forty-eight hours after the onset of pain. In this small series, the greatest number of positive findings were present between twelve and forty-eight hours after the onset of pain.

SUMMARY

1. The findings of the roentgen examinations of the abdomen in nineteen clinically proved cases of acute pancreatitis have been reviewed.

2. Patterns of gas distribution in the intestine have been noted. Dilated segments of ascending and transverse colon, dilated loops of small intestine, dilated stomach and duodenal arc, all with or without fluid levels, have been seen. The combination of any of these findings, and particularly dilated duodenal loop, is highly suggestive of acute pancreatitis.

3. The use of the left lateral decubitus position with a horizontal beam frequently reveals considerable amounts of gas hidden by bony structures on other views and better outlines the duodenal arc.

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VERTEBRAL ARTERIOGRAPHY OF THE BRAIN*

DETAILED DIAGRAM OF THE ARTERIAL BRANCHES IN THE FRONTO-OCCIPITAL ROENTGEN VIEW

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ILLUSTRATIONS of cerebral angiograms have appeared frequently in the neurosurgical and roentgen literature during the last few years. Angiograms are more easily interpreted with the help of schematic drawings. List, Burge and Hodges'[16] diagrams have aided us in becoming acquainted with the normal appearance of anteroposterior carotid and of lateral carotid and vertebral arteriograms. One can compare the course and caliber of the right and left cerebral vessels in the sagittal roentgenogram better than in a single or stereoscopic lateral view. However, no detailed diagram of the fronto-occipital (Chamberlain-Towne) projection of the vertebral system could be discovered in a review of the literature.† A schematic drawing of the normal vertebral arteriogram in the fronto-occipital view is therefore offered in the hope that it may help to interpret such films. Vertebral angiograms on more than 200 patients have been reported by a single author, and there seems to be no doubt that the method will be used more often in the future.[10]

INDICATIONS FOR VERTEBRAL ANGIOGRAPHY

The vertebral arteries are branches of the subclavian of either side. Their system supplies the brain stem, cerebellum and temporo-occipital lobes. Neurosurgeons[26,27] have advocated vertebral as well as carotid angiograms in suspected cerebral aneurysms, regardless of their presumed sites in the brain, before deciding on surgical intervention. This is done in order to localize single or multiple aneurysmal sacs and to determine adequacy of collateral circulation from both arterial sources. Vertebral angiography is also indicated in most vascular and many space occupying lesions suspected of lying in the areas supplied by the system of the vertebral arteries. Conditions such as occlusions, arteriovenous fistulas, malformations, subdural hematomas, abscesses and neoplasms may be diagnosed and exactly localized. Of the subtentorial tumors, acoustic neurinomas, angioblastomas (Lindau's disease) and glomus jugularis may give characteristic signs. Gliomas of the pons and tumors arising from the clivus and sella turcica have been demonstrated by vertebral angiograms. Sometimes a histopathological diagnosis by angiographic appearance is possible in meningiomas, astrocytomas and glioblastomas situated in the infratentorial and supratentorial regions supplied by the vertebral system. While tumors of the brain stem usually give reliable pneumographic signs, those of the pineal and thalamic regions have been localized more accurately by angiographic "blush" and gross vascular abnormality. In the presence of increased intracranial pressure it is at times potentially dangerous to fill the ventricles with air, as it may displace the contents of the posterior fossa. Angiography may be employed instead to prevent the latter complication, because it does not increase the volume of the cranial contents. It may also be preferred when postoperative recurrence is suspected, and pneumographic changes are difficult to interpret. The *contraindications* to contrast filling of the vertebral system are severe

† Bean's[1] chart shows a scheme "of the arteries of the base of the brain." This anatomic drawing is often mistaken for a roentgen projection of the arteries.

* From the X-ray Service, Brown General Hospital, Veterans Administration Center, Dayton, Ohio, and University of Cincinnati College of Medicine, Cincinnati, Ohio. Part of an Instruction Course given at the 54th Annual Meeting, American Roentgen Ray Society Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.

arteriosclerosis or hypertension, recent cerebral embolism or thrombosis, and are essentially the same as in carotid angiography.[3,6,12] Injection of contrast medium into the vertebral arteries should be used with particular caution to avoid edema or other damage to the vital centers in the brain stem. Antihistaminics may be added to the contrast medium in order to minimize reactions and complications.

Detailed description of *techniques* applied can be found elsewhere in the literature.[5,7,9,14,21,25,28] Three different methods are used: percutaneous puncture, catheterization and surgical exposure. Lindgren[15] performed 60 percutaneous injections of the vertebral artery and chose insertion of the needle between the transverse processes of the upper rather than the lower cervical vertebrae. He estimated this approach was possible in two-thirds of persons of middle age or older. Success depends on the skill of the operator and regional anatomical factors. With percutaneous injection in the lower neck, Freshwater[8] was successful in 51 of 68 patients. In 221 patients, Radner[20] passed a catheter in the radial artery, usually the right. He advanced the tip through the subclavian into the vertebral artery to the level of the third or second cervical vertebra. Open surgical exposure of the vertebral artery may be preferred when thorium dioxide solution is used, in order to avoid paravascular deposits. These methods produce better contrast than injection into the surgically exposed and distally compressed subclavian artery with retrograde filling, as originally described by Egas Moniz.

MATERIAL AND PROCEDURE

The arteries of twenty brains were dissected. Fifteen vertebral angiograms were performed on cadavers, usually with a thin barium suspension. This gave a high contrast and did not fill the terminal twigs, thus making the appearance of the larger vessels clearer. When nearly 4 milliliters of the suspension was injected, the barium streamed into the contralateral subclavian artery, indicating the approximate capacity of the vertebral system. Stereoscopic lateral and fronto-occipital arteriograms were taken. In six instances stereoscopic submentovertical views were added. In several formalin-hardened brains, specific branches were marked by metal clips and exposures made at different angles. The air filling of the ventricular system in the hardened specimen helped to identify the vessels. Angiograms after percutaneous injection of the vertebral artery of 50 living patients at our and other hospitals were studied. Fifty carotid arteriograms were examined for filling of the posterior cerebral artery.

The *lateral view* of the vertebral arteriogram is illustrated in Figure 1. The vertebral artery (*1*) with its sharp backward

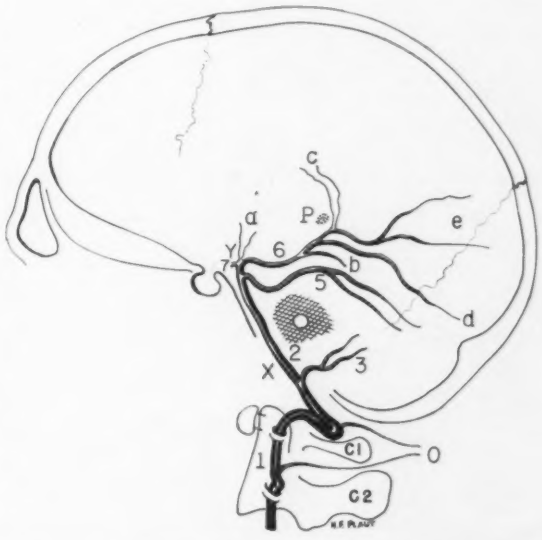

Fig. 1. Schematic drawing of the lateral vertebral arteriogram. (*1*) Vertebral artery. (*2*) Basilar artery. (*3*) Posterior inferior cerebellar artery. (*5*) Superior cerebellar artery. (*6*) Posterior cerebral artery; (*a*) posteromedial, thalamoperforating twigs, (*b*) branch to temporal lobe, (*c*) posterolateral, thalamogeniculate and posterior choroidal twigs, (*d*) branch to undersurface of occipital pole, (*e*) branch to medial surface of hemisphere. (*7*) Posterior communicating artery from internal carotid. (*O*) Anastomoses with occipital artery, which is a branch of the external carotid. (*P*) Calcification in pineal body. (*X*) Junction of right and left vertebral arteries. (*Y*) Terminal bifurcation of the single basilar into the posterior cerebral arteries.

turn along the sulcus of the posterior arch of the atlas is easily followed. It enters the dura, bends around the cord to the ventral aspect of the medulla and enters the occiput through the foramen magnum. Shortly before the right and left vertebrals unite (*X*) to form the single basilar artery (*2*), each gives off a posterior inferior cerebellar artery (*3*). The origin of the anterior inferior cerebellar arteries is obscured by the massive temporal bones. The basilar artery follows the bony incline of the clivus forward and upward. Close to its bifurcation it gives rise to bilateral superior cerebellar arteries (*5*), which extend backward and divide on the upper surface of the cerebellum. The terminal bifurcation (*Y*) of the basilar forms the posterior cerebral arteries (*6*), and lies either directly behind the posterior clinoids or as much as 1 cm. dorsal and 1 cm. superior to this landmark. The internal carotid is linked with the vertebral system by the posterior communicating arteries (*7*), which are occasionally visible in the vertebral arteriogram of the living.[5,20,24] They are always filled in the cadaver, because there is no counterpressure from the carotid. In about 25 per cent of cases (13 out of 50 carotid injections in our hospital) the posterior cerebral artery originates on one side from the internal carotid. It then may not be filled from the vertebral artery. The posterior cerebral arteries curve around the peduncle and sweep backward. Their temporal rami (*b*) branch off in a slightly downward direction, and their terminal branch for the parieto-occipital region is seen below the level of the pineal. Near the anterior edge of the tentorium this branch divides into two main twigs. One (*d*) extends slightly downward to the inferior surface of the occipital pole, the other one (*e*) slightly upward to the medial surface of the hemisphere near the parieto-occipital and calcarine fissures. On the drawing the overlapping of the supratentorial and infratentorial vessels of the same and of the opposite side is not shown. The overlap results from the inclination of the tentorium from the midline to the upper edges of the petrous bones.

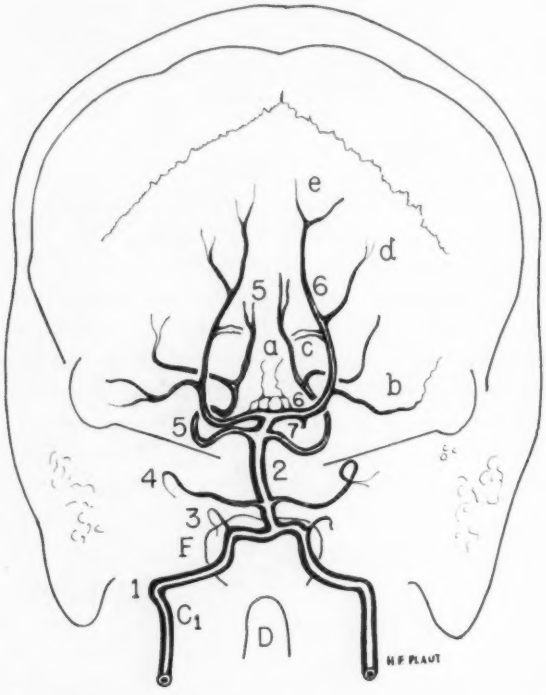

FIG. 2. Diagram showing the normal asymmetry of the vertebral arteriogram in fronto-occipital projection. (*1*) Vertebral artery. (*2*) Basilar artery. (*3*) Posterior and (*4*) anterior inferior cerebellar artery. (*5*) Superior cerebellar artery. (*6*) Posterior cerebral artery; (*a*) posteromedial twigs piercing the posterior perforate substance to supply the ganglia, mainly the medial surface of the thalamus, (*b*) branch to temporal lobe, (*c*) posterolateral twigs to pineal and thalamogeniculate regions, (*d*) branch to inferior surface of occipital pole, (*e*) branch to gyri near parieto-occipital and calcarine fissures. (*7*) Posterior communicating artery from internal carotid. (*C 1*) Level of first cervical vertebra (atlas). (*D*) Dens (odontoid process of axis). (*F*) Foramen magnum of occiput.

In the *fronto-occipital view* (Fig. 2) of the vertebral arteriogram the branches intersect at several points. Their normal anatomic course and pathologic deviations therefrom can be more easily followed if one remembers their winding path: The paired superior cerebellar arteries curve around the brain stem before branching on the surface of the cerebellum. The posterior cerebral arteries make a similar bend. They supply the cerebral ganglia and most gyri

in the temporal, occipital and adjacent parietal regions.

In 92 per cent of 150 brains examined[22] the vertebral arteries (*1*) were of unequal caliber. They swing laterally at the level of the axis and extend upward. Then they converge toward the midline upon the posterior arch of the atlas and pierce the dura. Before their junction on the ventral aspect of the medulla, each gives off a posterior inferior cerebellar artery (*3*). The latter supplies the under and medial surfaces of a cerebellar hemisphere but is seldom seen in this view.

The origin of the unpaired basilar artery (*2*) is noted near the upper edge of the foramen magnum (*F*), in the midline or lateral to it. Its course may be straight or curved, with the convexity toward the side of the smaller of the two vertebrals.[11] The first major branches of the basilar are the anterior inferior cerebellar arteries (*4*). These usually run toward the upper border of the petrous bones and loop over the anterior inferior surface of the cerebellum. The last major lateral branches of the basilar are the superior cerebellar arteries (*5*). The course of these vessels differs from that in the lateral view, where each lies below and nearly parallel to the posterior cerebral artery. Each crosses the latter twice in this projection, first near the lateral edge of the cerebral peduncle, and then before or after dividing and spreading over the cerebellum. Often the routes of the right and left superior cerebellar arteries are not symmetrical. This should be considered when one is looking for possible displacement and straightening of this vessel by an acoustic tumor.

The single basilar terminates in the right and left posterior cerebral arteries (*6*). Each anastomoses with a posterior communicating (*7*) and crosses a superior cerebellar artery. Beyond this intersection the posterior cerebral arteries ascend more or less parallel to the midline. Single, or occasionally multiple, branches for the temporal lobe (*b*) are given off. Near the uppermost point of the tentorium the posterior cerebral arteries approach each other and divide into branches. These do not normally extend beyond the lambdoid suture (see Fig. 2). The more lateral branches (*d*) wind to the undersurfaces of the occipital poles, the medial ones (*e*) supply the gyri of the medial surfaces of the hemispheres.

The submentovertical view may further contribute to the arteriographic study. It often shows the anastomosis of the posterior spinal arteries with occipital vessels. The relation of the arteries composing the circle of Willis is at times well demonstrated in this axial view. The cerebellar hemispheres are less rigidly held in place by their falx than those of the brain. Their displacement by tumor may be clearly seen in this projection.

VENOUS RETURN

The supratentorial region supplied by the vertebral system is drained by three paired veins: The internal cerebrals start at the foramen of Monro and follow the course of the posterior choroidal arterial branches, the basal veins (of Rosenthal) run fairly parallel to the stem of the posterior cerebral arteries, and the internal occipital veins are seen parallel to the temporal branches of the posterior cerebral arteries. These veins, together with fine rami from the pineal region, form the unpaired great cerebral vein (of Galen), whose lowest point is situated just above the pineal body. This fact may be helpful for localization when the pineal is not calcified. The posterior part of the occipital lobe is drained by the superficial occipital veins which empty into the superior sagittal sinus.

The subtentorial veins drain the medulla, pons and cerebellum. The superior cerebellar veins from the upper surface of the cerebellum empty into the great vein of Galen and also, with the inferior veins, into the transverse or petrosal sinuses. Of the dural sinuses only the unpaired straight sinus is regularly seen along the upper edge of the tentorium in the normal vertebral phlebogram. In the lateral view it forms

with the great vein an angle which varies around 90°. About four seconds after vertebral injection the density of most of these veins is diminished by admixture of blood from the carotid system. Two seconds later only the dural sinuses may be visualized. In the fronto-occipital view there is much overlapping, so that some authors prefer to take it at a 5° angle. This has the disadvantage that slight lateral deviations are not well recognized. In the axial view the differentiation is even more difficult.

One gross *anomaly* and many *variations* of the origin, course and caliber of the branches of the vertebral artery were discovered in the roentgenograms and specimens examined. They can be explained as remnants of anastomoses and transitory branches in the embryo,[2,4,11,13,19,22,23,25] but their description is beyond the scope of this discussion. One should consider anomalies and variations when interpreting roentgenograms. While their significance has been questioned by some authors, their discovery before a planned ligation may become vitally important to the patient.

SUMMARY

The usefulness of vertebral arteriography has been demonstrated in reports of large series. One may expect this method to be employed more often in the future. Vertebral angiography is indicated in vascular and many space occupying lesions suspected of involving the posterior fossa, brain stem, or lobes supplied by the system of the vertebral arteries. The course of the vessels in the lateral and fronto-occipital (Chamberlain-Towne) projection of the vertebral arteriogram is described as noted in the living and the cadaver. One can compare the vessels of the right and left side in the fronto-occipital view better than in a single or stereoscopic lateral projection. However, a review of the literature revealed no detailed schematic drawing for the interpretation of the vertebral arteriogram taken in sagittal direction. A diagram of this fronto-occipital projection is therefore presented. The normal asymmetry of the arterial course and caliber in this view is emphasized.

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The author is indebted to the neurosurgeons, Louis A. Hazouri, Oscar Sugar and Edward J. Sullivan, and the pathologist, Alden S. Thompson, for their assistance in this study and to the medical illustrator, Mary Maciel, for her help with the drawings.

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THE INCIDENCE AND COMPOSITION OF RADIOPAQUE DEPOSITS IN THE BASAL GANGLIA OF THE BRAIN*†

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RECENTLY much emphasis has been placed on the differential diagnosis of intracranial cerebral calcifications seen on skull roentgenograms,[3,7,8] especially by the group at the Mayo Clinic.[2,4] However, this method is not highly sensitive, and at times negative skull films can be obtained in the presence of vascular cerebral calcifications which can be demonstrated at autopsy.[1,10] With the development of a very sensitive method for detecting radiopaque deposits in tissue slices,[9] a study was undertaken to correlate the sensitivity of this method with histochemical studies and to determine the frequency of occurrence of radiopaque deposits in the basal ganglia.

MATERIAL

Two hundred consecutive brains from routine autopsies were obtained from several large general hospitals in Baltimore, Maryland.* This material was entirely unselected, except that patients under fifteen years of age were excluded.

After fixation in neutral 10 per cent formalin for a minimum two week period, a coronal section 0.75 cm. in thickness was obtained, the rostral limit passing through the middle of the optic chiasm and the anterior white commissure.

METHOD

These sections were roentgenographed on cardboard folders, using screen film and a fully extended cone. They were exposed at a distance of 75 centimeters (30 inches) for 20 milliampere seconds at 32 kilovolts. This slight modification of a previous procedure[9] permitted routine development at 68° F. (20° C.) for three minutes.

Sections were then taken from the area of the basal ganglia, especially the globus pallidus, for histological examination with routine hematoxylin and eosin stains, Gomori's modification of Perl's stain for iron, and von Kossa's stain with sunlight reduction[5] for calcium. Further histochemical investigations of these deposits will be reported in the near future.

RESULTS

Radiopaque deposits were found bilaterally in the region of the basal ganglia in 4 cases, an incidence of 2 per cent. Unfortunately, previous skull roentgenograms of these patients were not taken.

DISCUSSION

It is of interest that 68 per cent of the 200 cases showed basophilic vascular granular deposits in the basal ganglia histologically, although only 2 per cent exhibited radiopacity of this region. At first these basophilic granular deposits were thought to contain calcium. However, further histochemical studies showed that only very few cases contained calcium, including the 4 with radiopacity.

Since all of the deposits contained iron on histochemical examination, it was pos-

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† Aided by a grant from the Sidney M. Cone Research Fund.

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sible that the iron deposits were responsible for the radiopacity. However, when a piece of liver from a case of hemochromatosis and a piece of normal liver of equal thickness were roentgenographed using the same technique, no radiopacity could be demonstrated, although the hemochromatotic liver showed denser iron deposits histochemically than the brain sections. It was then concluded that the radiopacity was due to the calcium content of the deposits. This correlated with the histochemical findings, in which the sections exhibiting radiopacity contained denser calcium deposits than those which were not radiopaque. The roentgenological method thus approached, but did not equal, the sensitivity of the histochemical procedure.

The 4 cases showed no obvious common clinical features, except for age. They were all over the age of fifty-five (65, 67, 64, and 56). All died of different unrelated causes (epidermoid carcinoma of the lower lip, bleeding gastric ulcer, coronary atherosclerosis with myocardial infraction, and carcinoma of the prostate with widespread —but no cerebral—metastases). Two of the 4 had generalized atherosclerosis.

As noted, iron-containing deposits occur in the globus pallidus in 68 per cent of routine autopsies without predilection for any specific disease condition. There is, however, a definite increase in incidence with advancing age. With certain cerebral, vascular, or metabolic lesions, these deposits become more extensive and usually contain calcium. However, before any of these conditions is diagnosed from a skull roentgenogram, it may be well to remember the small 2 per cent of cases in which these radiopaque calcium-containing deposits occur without any demonstrable clinical cerebral manifestations.

CONCLUSIONS

Radiopaque deposits occur in the region of the basal ganglia in 2 per cent of routine autopsy cases in a general hospital. This radiopacity appears to be due to calcium, which is deposited in a basophilic, iron-containing material which is present in the blood vessels of 68 per cent of these cases. The incidence appears to be related to age, but not to the disease process. Although these deposits become much denser and contain calcium under certain pathologic conditions, before these are diagnosed, it may be well to remember that 2 per cent occur in random autopsies without relation to specific disease conditions.

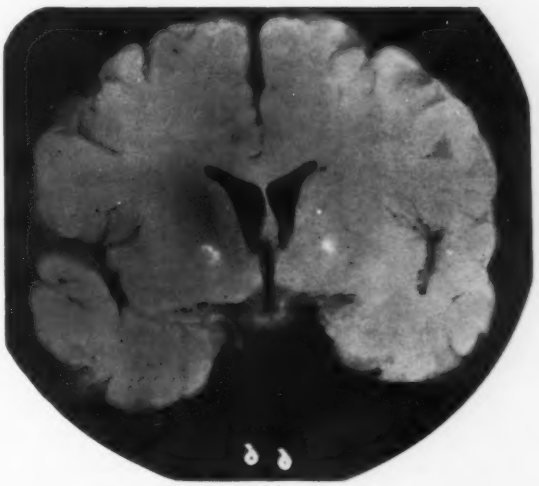

Fig. 1. Roentgenogram showing bilateral radiopaque deposits in the basal ganglia. A sixty-seven year old patient died with actively bleeding gastric ulcer.

SUMMARY

1. Sections of uniform thickness and consistent location were obtained from each of two hundred brains from consecutive autopsy material in four large general hospitals.

2. Roentgenograms of these brain slices were taken with a sensitive method here described.

3. Two per cent of these brains showed radiopaque deposits in the basal ganglia.

4. The presence of radiopacity correlated with the histochemical demonstration of calcium, but not with that of iron.

5. A short summary of clinical and histochemical correlation of these findings is presented.

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Vol. 74, No. 2

ACUTE DIFFUSE PNEUMONIA OF ASTHMATICS*

By BENJAMIN FELSON, M.D., AND HENRY FELSON, M.D.
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IT IS well known that patients who suffer from bronchial asthma are particularly susceptible to attacks of acute pneumonia. The pneumonia usually presents itself roentgenographically as a localized pulmonary density, sometimes associated with lobar or segmental collapse. This roentgen appearance has frequently been described in the literature.[8,10,13,15] However, a much more diffuse pneumonic process is also encountered in asthmatics. This diffuse pneumonia of asthmatics, which has received scant attention in the literature, forms the basis for the present report.

In 1931, Zdansky[15] noted roentgen evidence of pulmonary infiltration accompanying an acute febrile respiratory illness in 6 of 70 asthmatic patients. Two of the 6 cases showed transient disseminated peribronchial densities, particularly in the basal portions of the lungs, these changes being attributed to foci of bronchopneumonia and atelectasis.

In various other reports on the subject of bronchial asthma, brief mention is made of the occurrence of enlargement of the hili, accentuation of the central markings, and coarse mottling of the lungs during acute asthmatic attacks.[1,2,4,9,11,12] None of these articles, however, deal specifically with acute diffuse pneumonia, and no clear-cut description of this condition was found in a review of the literature.

The present report consists of a study of 16 cases of acute diffuse pneumonia of asthmatics seen at the Cincinnati General Hospital. Three of the cases had two attacks each, so that a total of nineteen acute episodes were encountered. One autopsy is included. All of the 16 cases were encountered on the medical service during the period between 1946 and 1952,† during which time about 14,000 patients were admitted to this service. Prior to that time, we were unaware of this condition and these cases doubtlessly went unrecognized. The clinical, laboratory, and roentgen data in these 16 cases are summarized in the following sections.

Clinical Findings. The average age of the group was forty-seven years, the youngest patient being thirteen years of age and the oldest eighty-four. There were 8 males and 8 females. It is interesting to note that only 2 (12 per cent) of the patients were Negroes, although the latter account for 47 per cent of the total admissions to the Cincinnati General Hospital.

The pattern of the acute attack was not particularly characteristic or consistent. The onset was abrupt in more than half the cases and gradual in the remainder. Duration of acute symptoms prior to admission was usually less than a week.

Fever was present in all but two of the nineteen attacks. The highest temperature was usually between 100° and 104° F. Symptoms were chiefly respiratory in nature. Cough and dyspnea were prominent in almost all instances and many of the patients noted respiratory wheezing, but these symptoms were not of the severity usually associated with attacks of asthma. Less common symptoms included chills, cyanosis, purulent sputum, anorexia, and weakness.

Physical findings consisted chiefly of expiratory wheezes, coarse rhonchi, and râles. These varied considerably in degree, type, and distribution. There was no evidence of significant heart disease.

In 13 cases, past history revealed definite bronchial asthma, characterized by frequent paroxysmal attacks of dyspnea and wheezing, usually of many years' duration. In each case a diagnosis of asthma had

† Four additional cases have been seen since this article was completed.

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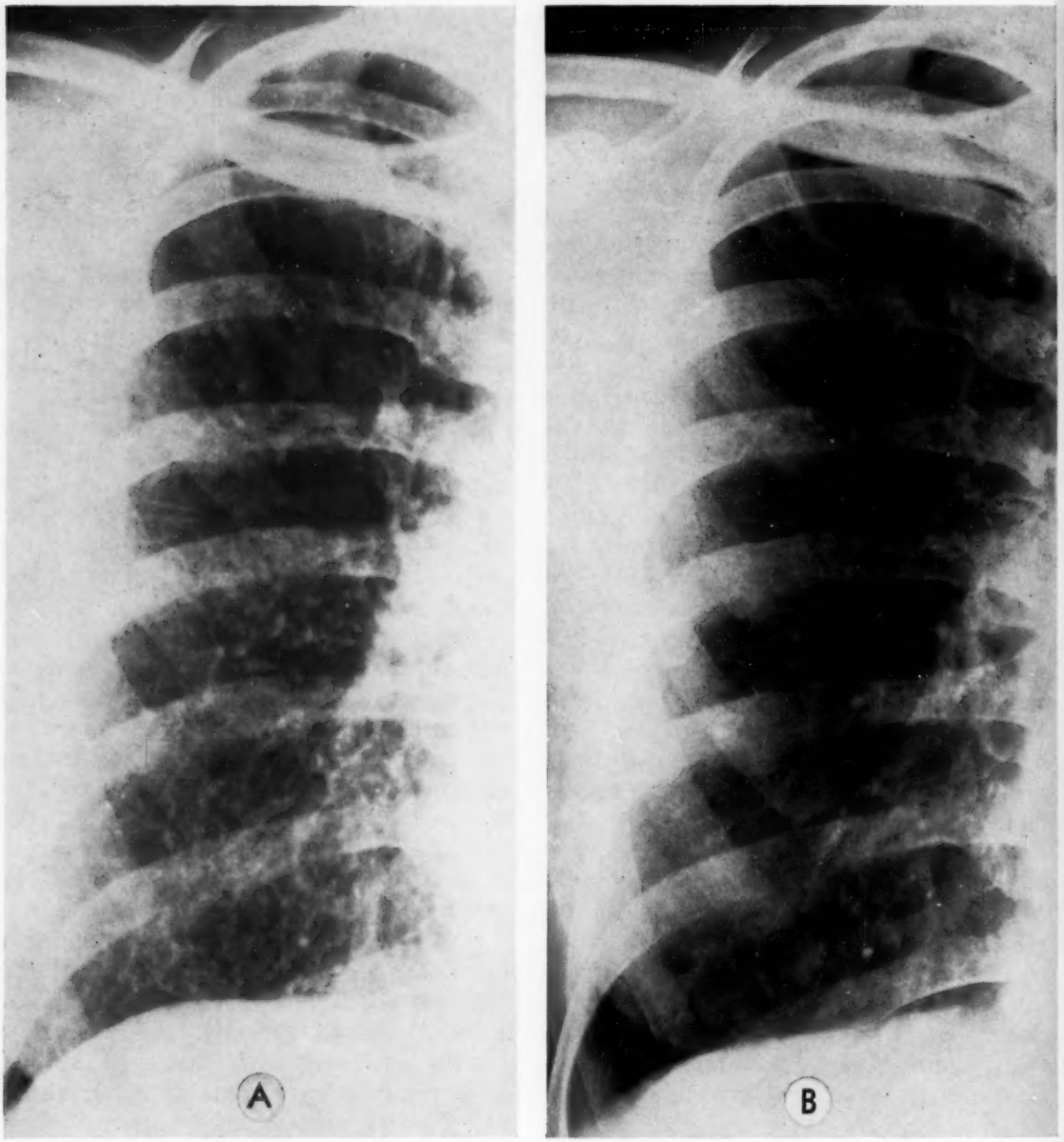

Fig. 1. White female, aged 23. History of attacks suggestive of asthma since childhood. Cough, dyspnea, and fever for two days before admission. Temperature 102.4° F.; white blood cell count 15,000; type 8 pneumococcus in sputum. (*A*) Admission roentgenogram: diffuse ***miliary*** pattern, which was bilateral. (*B*) One month later: lung fields clear. Patient was clinically well three weeks after admission.

been made by several observers. In the remaining 3 cases, the history of asthma was not so definite. One patient was an eighty-four year old man who could not give a history; according to earlier records, chronic cough and wheezing had been present for at least six years. The second patient was a twenty-three year old female, with a family history of asthma. Between the ages of eight and fourteen, she had repeated attacks of "bronchitis" and subsequently noted similar episodes during each of three pregnancies. She had been treated for asthma in the Allergy Clinic with some ben-

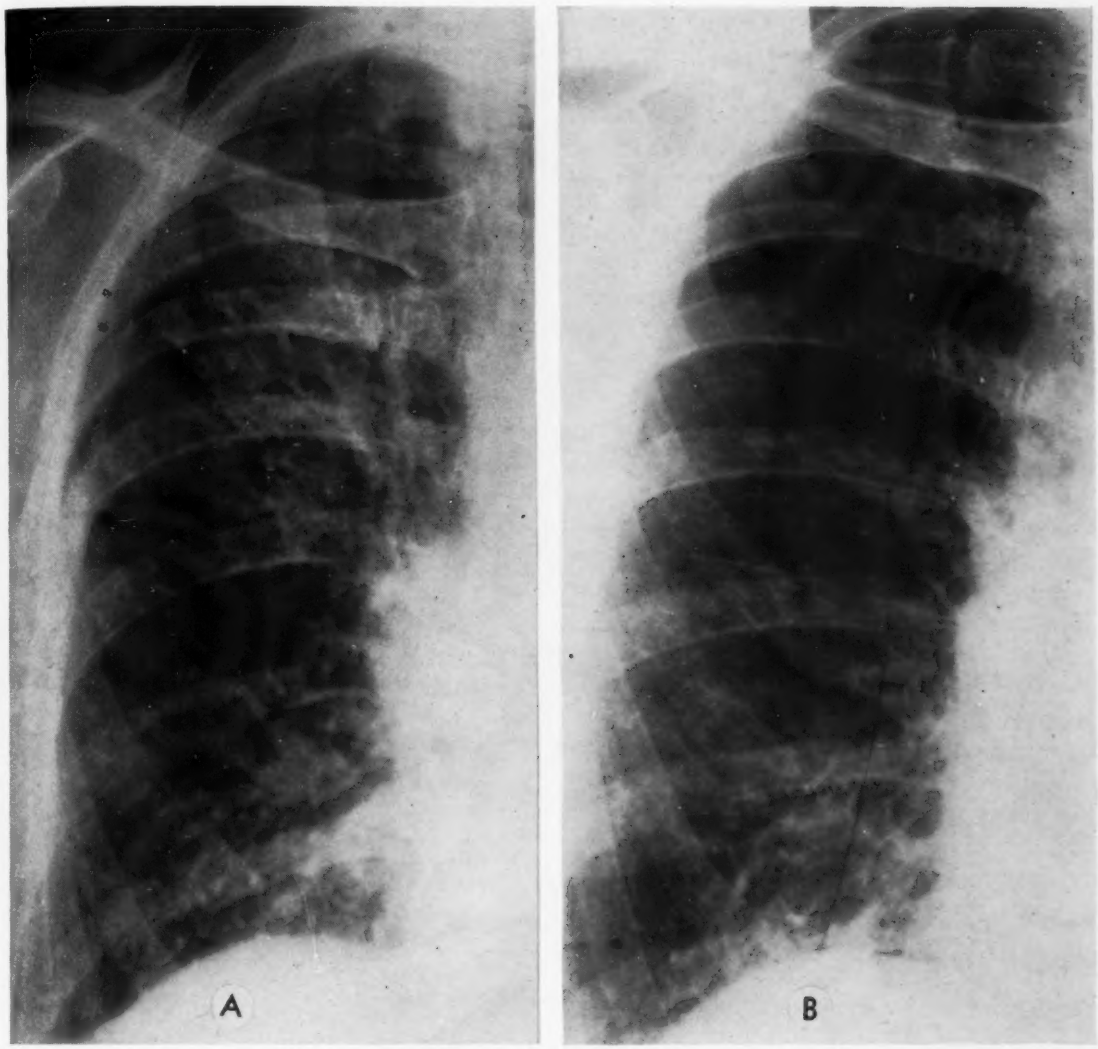

Fig. 2. White female, aged seventy-two. Asthma "all her life." Cough, dyspnea, and fever for three weeks before admission. Temperature 103°F.; white blood cell count 26,000; sputum normal. (*A*) Admission roentgenogram: diffuse *peribronchial* pattern, which was bilateral. (*B*) Ten days later: lungs essentially clear. Patient was clinically well one week after admission.

efit. The third case was that of a sixty-four year old woman, with a ten year history of attacks of cough and dyspnea without wheezing, especially at night. In all 3 patients a diagnosis of bronchial asthma had been made at one time or another.

Laboratory Findings. On admission, the white blood cell count was normal in three instances and elevated to a varying degree in the remainder. In four of the nineteen attacks, the count was above 20,000. Polymorphonuclear leukocytosis was usually found, but in no instance was eosinophilia present. Sputum was moderate in amount and mucopurulent or purulent. It was studied by smear and/or culture in fifteen of the nineteen attacks. Pneumococci predominated in eleven instances, *H. influenzae* in two, and staphylococci in two. Other laboratory studies were nonrevealing.

Roentgen Findings. Roentgenograms on admission showed widespread pulmonary densities, bilateral in sixteen instances and unilateral in three. Two predominant pat-

terns were seen: "miliary" nodulation in eight and "peribronchial" infiltration in eleven.

The *miliary* pattern (Fig. 1) simulated that of miliary tuberculosis; this diagnosis was, in fact, suggested in several of the cases. In each case, the nodules were rather uniform in size, with ill-defined margins. They measured from 2 to 6 mm. in diameter. The lesions were distributed throughout both lungs in 6 instances, and were confined entirely to the right lung in 2. They appeared less numerous at the periphery than in the central portions of the lungs.

The *peribronchial* pattern (Fig. 2) was similar to that seen in pulmonary venous congestion. The pulmonary densities appeared more linear, and often seemed to follow the distribution of the vascular markings from the hili toward the lung periphery. In 10 instances the distribution was bilateral; in 1, it was confined to the right lung (Fig. 3). The densities usually appeared more prominent centrally than peripherally.

Of the 3 patients who suffered two attacks, 1 showed a bilateral peribronchial pattern with the first episode and a unilateral miliary pattern with the second (Fig. 4). The other 2 cases showed a miliary appearance during one attack and peribronchial during the other, bilateral on both occasions.

As is frequently the case in diffuse pulmonary diseases,[6] differentiation between the two patterns was often difficult. In some cases classified as *peribronchial* there was a suggestion of miliary lesions, and the reverse was also noted. Because of this overlapping roentgen appearance, and because the clinical data were similar in the two groups, we believe that the miliary and peribronchial patterns represent slightly different roentgen manifestations of the same pathological process.

Slight or moderate hilar enlargement was noted during the acute attack in only 4 instances. Diffuse pulmonary emphysema was not a feature during the episodes. Slight transient cardiac enlargement occurred during the acute attack in 2 cases. There appeared to be no significant correla-

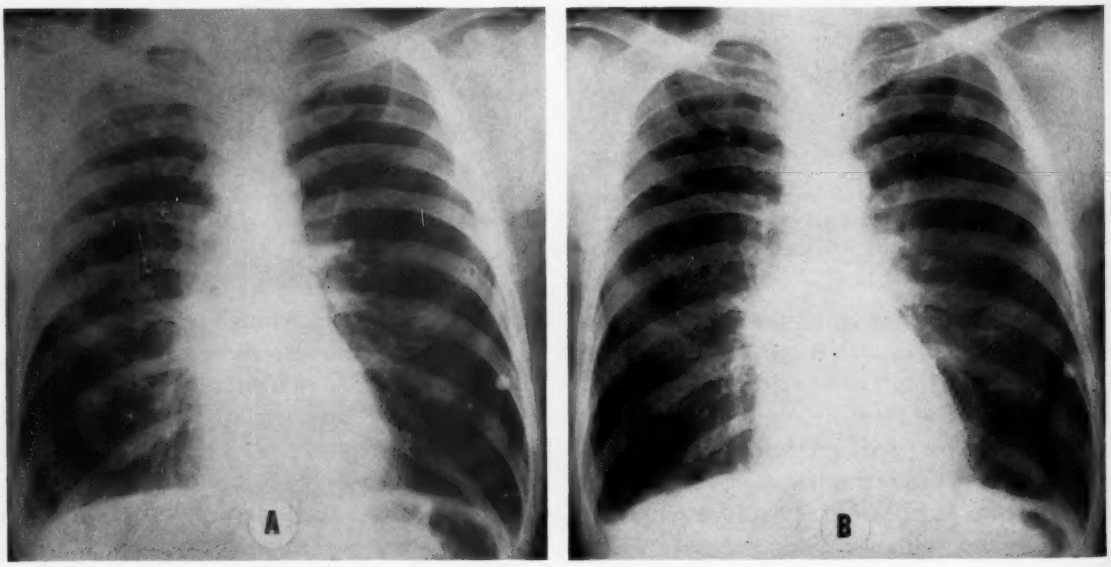

Fig. 3. White male, aged forty-nine. Asthma "all his life." Productive cough and dyspnea for four days before admission. Temperature 102° F.; white blood cell count 25,000; pneumococci in sputum. (*A*) Admission roentgenogram: unilateral *peribronchial* infiltrate. (*B*) Three weeks later: emphysema and exaggerated bronchovascular markings persisted, but the pneumonia on the right had cleared.

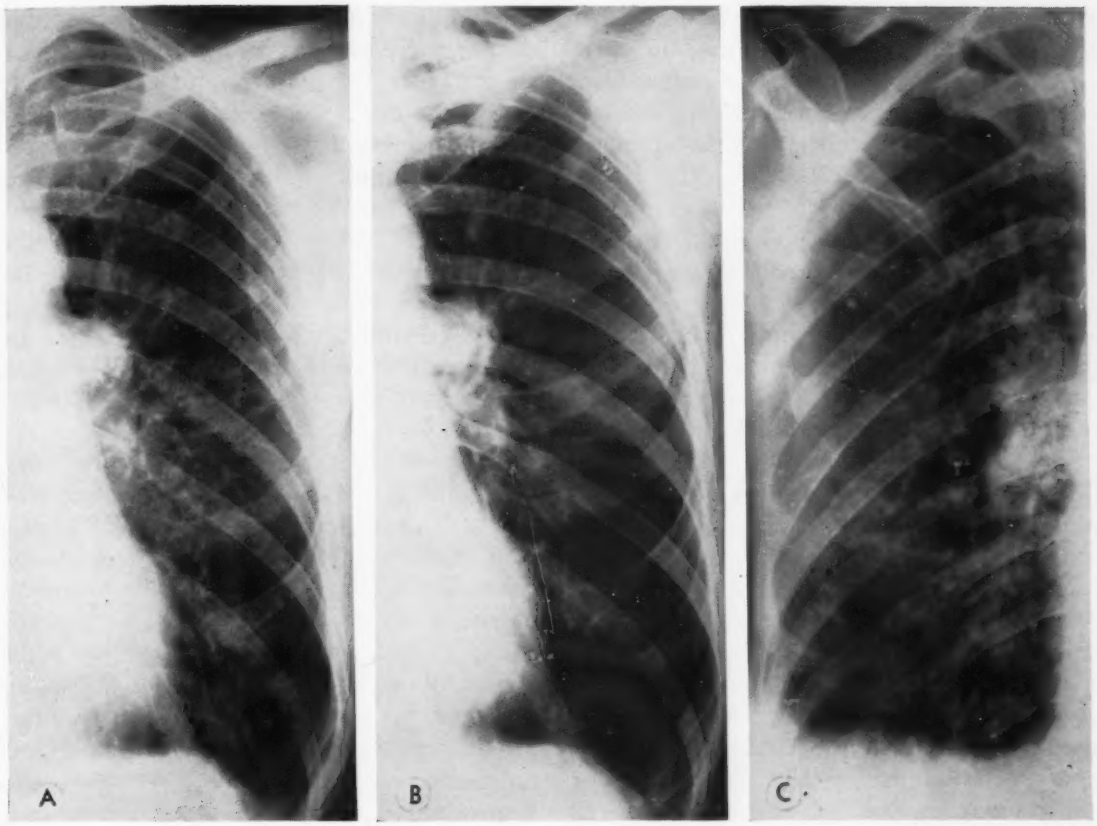

Fig. 4. White male, aged fifty-one. Asthmatic attacks for fifteen years. Dyspnea and wheezing for three days prior to admission. Temperature 100° F.; white blood cell count 14,000; pneumococci in sputum. (*A*) Admission roentgenogram Dec. 24, 1945; diffuse *peribronchial* infiltrate, which was bilateral. (*B*) Jan. 3, 1946: lungs clear. (*C*) Sept. 28, 1947: similar acute episode, with diffuse *miliary* lesions confined to right lung. Patient died next day; no autopsy.

tion between the degree of roentgen change and the severity of the clinical manifestations.

Roentgen evidence of chronic pulmonary disease was often present in the form of pulmonary emphysema, localized or diffuse accentuation of the bronchovascular markings, large hilar shadows, and pleural adhesions. These findings were usually overshadowed by the acute process but were detected on subsequent films.

Clinical Course. The acute symptoms usually persisted for about a week after admission, or two weeks from the time of onset. Complete clearing of the infiltrate on the roentgenogram lagged almost a week behind clinical recovery.

All of the patients received one or more antibiotic, and some received bronchodilator drugs, but no uniform response was noted. In 3 instances the response was excellent; in 7, it was moderate; and in 7 others, in whom the temperature fell by lysis, the efficacy of the therapy was considered questionable or poor. Two patients died during the acute episode, despite vigorous antibiotic and supportive therapy.

Pathology. No autopsy was performed in either of these 2 fatal cases. However, an autopsy was obtained in one of the other patients who had recovered from the original attack, but returned to the hospital with a similar acute illness one year later, and died. A roentgenogram was not obtained on the final admission. Autopsy showed innumerable nodular foci, 1 to 2.5 mm. in diameter, distributed rather uniformly throughout both lungs. Microscop-

ically, these nodules proved to be foci of acute suppurative bronchiolitis and peribronchiolar lobular pneumonia. Capillary bronchiectasis, chronic pulmonary emphysema, and pleural fibrosis were also present.

DISCUSSION

Acute disseminated pulmonary infiltration of the type here described is encountered in many diseases, including miliary tuberculosis, histoplasmosis, chickenpox, Loeffler's syndrome, and primary atypical pneumonia.[5] In our experience, however, many patients showing widespread acute pulmonary lesions are asthmatics. The frequency of this combination cannot be explained by chance alone, and we have been forced to conclude that a cause and effect relationship exists between the bronchial asthma and the disseminated acute pulmonary disease.

Further experience will be needed in order to give a more exact description of the structure and pathogenesis of the pulmonary lesion in this disease. While the autopsied case showed widespread acute bronchiolitis and peribronchiolar pneumonia, it would be premature at this point to conclude that pneumonia is necessarily the basic lesion in *all* instances, inasmuch as there are several alternate explanations to be considered. One possibility is that of widespread bronchiolar collapse, resulting from mucous plugs. These plugs are commonly found in the smaller bronchi at autopsy after fatal attacks of bronchial asthma.[7,8,14,15] A second explanation to be considered is pulmonary congestion secondary to bronchial spasm or to heart failure.[2,4,9,11] Pulmonary allergy (Loeffler's pneumonia) is another possibility.

However, the following evidence speaks against these explanations, and points rather toward an inflammatory process. In the first place, the patients covered in this study presented the clinical appearance of acute pneumonia, rather than that of an attack of bronchial asthma. In some cases temperatures over 104° F. and white blood cell counts above 20,000 were recorded. Bronchiolar collapse and bronchospasm alone, therefore, are unlikely causes. Secondly, there were no significant clinical, roentgenologic, or electrocardiographic signs of heart disease to account for pulmonary congestion. Finally, the absence of eosinophilia in the blood and sputum ruled out Loeffler's pneumonia. It should also be noted that unilateral involvement, as encountered in 3 instances in this series, would be difficult to explain except on an inflammatory basis.

It is possible that acute diffuse pneumonia also occurs in the course of chronic pulmonary diseases other than bronchial asthma. Cardon *et al.*[3] have described episodes of acute suppurative bronchitis and bronchiolitis in such chronic pulmonary conditions as emphysema, asthmatic bronchitis, pulmonary fibrosis, and bronchiectasis. Their pathological findings resemble those in our autopsied case. The 3 cases in our series with indefinite history of asthma might also represent instances of chronic nonasthmatic lung disease. Perhaps, then, acute diffuse pneumonia will prove to be a complication of chronic lung disease rather than specifically of bronchial asthma, as the present evidence seems to indicate.

It is important to emphasize the fact that the diagnosis cannot be made from the roentgen findings alone. As previously stated, there are a number of other conditions which produce acute diffuse pulmonary lesions. However, the occurrence of this particular roentgen appearance in a patient with an acute febrile illness and a past history of bronchial asthma is essentially diagnostic of the disease. In a number of the later cases in this series, the history of bronchial asthma was obtained after the possibility was suggested by the diffuse pulmonary infiltrate and the clinical symptoms of acute pneumonia.

The recognition of *acute diffuse pneumonia of asthmatics* is important not only for early diagnosis and treatment, but also for differentiation from miliary tuberculosis and other diffuse pulmonary conditions. The identification of this condition provides

an opportunity of segregating still another entity from the large and diagnostically complex group of diffuse pulmonary diseases.

SUMMARY AND CONCLUSIONS

1. *Acute diffuse pneumonia of asthmatics* is an acute febrile respiratory disease which is occasionally fatal. Observations on sixteen cases are reported.

2. Roentgenograms reveal disseminated pulmonary infiltrate showing either a "miliary" or "peribronchial" pattern, with clearing in two to four weeks after onset.

3. Autopsy in one case showed acute diffuse suppurative bronchiolitis and nodular peribronchiolar pneumonia.

4. The combination of diffuse pulmonary lesions, acute febrile illness, and a history of bronchial asthma appears to be diagnostic of this condition.

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METASTATIC MELANOMA OF THE STOMACH*

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THE stomach is a frequent primary site of malignant tumors but metastases to this organ are rare. However, in spite of their rarity, Willis[17] collected from the literature 53 cases of metastatic tumors of the stomach, 17 of which were melanomas and 12 were from carcinoma of the breast. He added 2 more cases of his own. One of them was from carcinoma of the thyroid and the other with the primary site in the pharynx.

Review of the literature leaves the impression that the demonstration of gastric metastases is primarily a post mortem finding.[2,3,5,6,8,9,10,13,14,16] The polypoid characteristics of submucosal metastases have been well described from autopsy material,[3,9,11,16] but only Richman and Lipsay[12] have published roentgenograms of the gastrointestinal tract showing metastatic melanoma. The purpose of this paper is to describe and illustrate the appearance of gastric metastases from melanotic tumors and to emphasize that they do occur in the stomach and can be demonstrated in vivo.

REPORT OF CASES

CASE 1. A white male, aged forty-four, was admitted to M. D. Anderson Hospital for Cancer Research on March 13, 1953, complaining of anemia and indigestion of three months' duration.

In 1947 the patient noticed that a "black wart" which had been present on the left wrist since his youth, began to increase in size. He consulted a physician who removed it surgically, and the patient was told that "it was malignant but dormant." He had no further symptoms or signs of disease until November, 1952, when he noticed a painless lump in the left axilla, which was biopsied and found to be malignant melanoma. Roentgen therapy was given to the axilla. Recently he developed indigestion, tarry stools and severe anemia requiring repeated blood transfusions. He had lost 40 pounds in weight in the last year.

Physical Examination. The patient was extremely pale and chronically ill. There was no evidence of superficial adenopathy or subcutaneous nodules except for induration in the left axilla. No abdominal masses could be palpated. Blood pressure was 110/80.

Roentgen Examination. Roentgenograms of the chest were negative. Roentgen examination of the gastrointestinal tract revealed a polypoid mass 8 cm. in diameter in the greater curvature side of the middle third of the stomach (Fig. 1). This was considered to be a malignant tumor, and although the possibility of metastatic melanoma was considered, the diagnosis of carcinoma was offered as the first possibility.

Laboratory Findings. Red blood cell count, 2,600,000; hemoglobin, 7.4 gm.; white blood cell count, 6,500; Kline test negative. Melanoma test in urine was negative.

Hospital Course. The patient continued losing blood during his hospitalization, requiring numerous blood transfusions. Although it was recognized that it would be only a palliative procedure, it was thought that the gastric lesion should be resected to prevent further hemorrhage. On April 6, 1953, the patient was taken to surgery and the operative record shows that there was a large mass in the stomach. There were numerous hard lymph nodes in the gastrocolic and gastrohepatic ligaments. The duodenum was divided approximately 1 cm. below the pylorus. The distal portion of the stomach was resected and an anastomosis to the duodenum was performed.

Microscopic examination of the resected stomach revealed metastatic malignant melanoma in the mucosa, submucosa and muscular wall (Fig. 2). Nine lymph nodes were recovered and 5 showed metastatic melanoma. The patient was discharged from the hospital slightly improved, but it is known that he has entered

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Fig. 1. Case 1. Polypoid mass in the middle third of the greater curvature of the stomach.

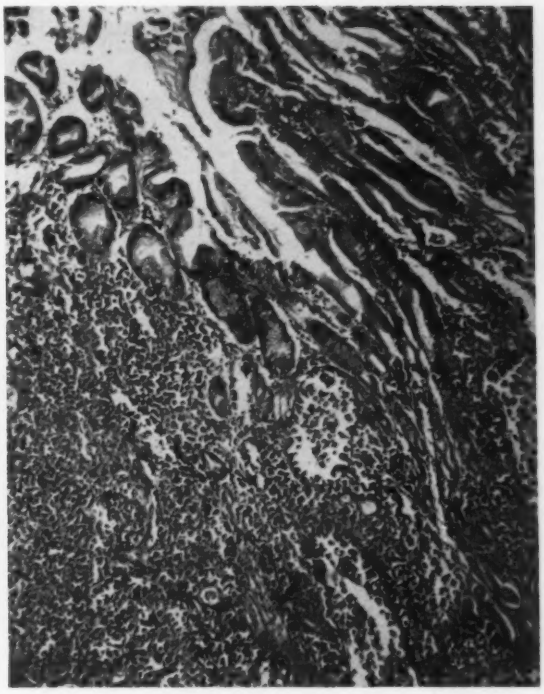

Fig. 2. Case 1. Photomicrograph, low power magnification, showing the invasion of the gastric wall by melanotic cells.

another hospital recently in very critical condition with jaundice, cervical and cerebral metastases.

Case II. A white male, aged sixty, was admitted to M. D. Anderson Hospital for Cancer Research in June, 1953, complaining of "nodules throughout the body," of one year's duration.

The patient had been in good health until about one year ago when he noticed changes in a "birth-mark" he had on the right elbow. At the same time he noticed the presence of a subcutaneous nodule on the right arm. Slight dyspnea has been progressing since that time. He had not had medical advice until two months ago when the diagnosis of melanoma was established histopathologically and was confirmed by the Department of Pathology of our hospital as an amelanotic melanoma. At this time the patient had numerous nodules in the anterior and posterior chest walls as well as in the abdominal wall. He began complaining of anorexia and slight postprandial pain two months prior to his admission to the hospital.

Physical Examination. There were numerous small subcutaneous nodules scattered throughout the body, mainly in the chest and abdominal walls. The original lesion in the right elbow was dark bluish and measured 5 cm. in diameter. Otherwise the examination was negative.

Roentgen Examination. Stereoscopic films of the chest showed multiple pulmonary metastases. Examination of the gastrointestinal tract revealed a small polypoid lesion in the middle third of the stomach. It had a small spot of barium in the center (Fig. 3). In the supine position, moving the air bubble of the stomach to the antral region a double contrast study of the lesion was obtained and the appearance was that of a small doughnut (Fig. 4). Gastroscopic examination showed a submucosal tumor 5 cm. in diameter in the anterior wall. It had a dimple formation in the center but was not ulcerated. No biopsy could be obtained.

Laboratory Findings. Red blood cell count, 3,000,000; hemoglobin, 10 gm.; white blood cell count, 10,000; Kline test, negative. Melanoma test in urine was negative.

The patient received rabies vaccine and triethylene-phosphoramide on an experimental basis. While in the hospital he developed jaundice, apparently due to liver metastases. He was discharged with a hopeless prognosis

FIG. 3. Case II. Spot roentgenogram of the distal third of the stomach. The polypoid appearance of the lesion is evident. There is a small spot of barium in the center.

and died at home in July, 1953. No autopsy could be obtained.

Comment. Although no histological proof of the gastric lesion could be obtained in this case, the fact that there were numerous melanotic nodules throughout the body as well as pulmonary metastasis, plus the roentgenographic and gastroscopic appearance of a polypoid tumor makes the presumptive diagnosis of metastatic melanoma of the stomach the most likely possibility.

DISCUSSION

Metastases from melanoma have been found almost everywhere in the body. Their implantation in the placenta has been recognized and even their transmission to the fetus of a melanotic mother has been recorded by Weber, Schwartz and Hellenschmied.[15] Metastases to the stomach are probably more frequent than has been reported, as many of the cases of generalized melanomatosis have shown gastrointestinal complaints but have not been exhaustively investigated.[4] Although cases of primary melanoma in the gastrointestinal tract have been described,[6] it is highly questionable that such a tumor may arise in the stomach or in the intestine. Herbut and Manges[9] have already pointed out that such a statement cannot be accepted, as melanoma is always primary in the skin or eye. They recommend ophthalmoscopic examination in the routine investigation of generalized melanomatosis when in search of the primary site. Our cases, with known primary lesions in the skin, corroborate this opinion.

The macroscopic description of cases reported in the literature impresses one as being that of submucosal tumor masses in the digestive tract. Many of these cases described show this pattern and it would be expected that metastatic melanoma would have a polypoid roentgen appearance. Bockus[1] has recognized the clinical possibilities of discovering them and has advised routine roentgenographic investigation of the stomach in patients with melanomas of the skin or eyes, if they have gastrointestinal complaints. Our cases had symptoms or signs referable to the stomach.

If the examination of the stomach is negative, the radiologist should not feel satisfied until the small and large intestine have been investigated as they are also frequent sites for metastatic melanoma which may produce obscure and misleading

FIG. 4. Case II. Double contrast was obtained in the supine position by moving the air bubble of the stomach to the antrum. In this view the lesion resembles a small doughnut.

symptomatology. Although the patients may not derive any particular benefit from the diagnosis of gastric metastases, it is still a challenge to the radiologist to recognize that they do occur and to demonstrate them when they are present.

CONCLUSIONS

1. Two cases of metastatic melanoma to the stomach are reported with roentgenographic demonstration.
2. Both cases show a polypoid appearance in the roentgenograms.
3. From the macroscopic description of postmortem findings in cases previously reported, it seems that a polypoid appearance is the more constant pattern in gastric metastases from melanoma.
4. Patients with generalized melanomatosis and gastric complaints should have roentgenological examination of the gastrointestinal tract to uncover possible gastric metastases.

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SMOOTH-MUSCLE TUMORS OF THE ALIMENTARY TRACT

THEIR ROENTGEN MANIFESTATIONS*†

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SMOOTH-MUSCLE tumors of the alimentary tract include both benign leiomyomas and malignant leiomyosarcomas. They represent a localized tumefactive overgrowth of the muscularis of the bowel, the cause of which is unknown. They are not commonly seen, but do comprise about 1 per cent of all tumors of the gastrointestinal tract.[6,8,14]

Reports in the scientific literature of the world, with regard to these lesions, are rather numerous. Most of these reports are concerned with the medical, surgical and pathologic aspects, and as a consequence the clinical symptoms and signs are well known to all. Unfortunately, the symptoms and signs are not unique to leiomyomatous neoplasms and are therefore not too helpful in arriving at a definitive diagnosis.

Examination of the alimentary tract by roentgenologic means is the best method which can be used to locate these tumors and to determine their character prior to surgical excision. Because of the importance of the roentgenologic examination, this study was undertaken to emphasize again to all roentgenologists the appearance of these tumors.[14]

LITERATURE

Moore, in 1924, was the first to report the roentgenologic aspects of a group of benign intraluminal gastric tumors, many of which were leiomyomas. In general his diagnostic criteria were as follows: 1. The tumors produce a filling defect that is circumscribed and punched out in appearance. 2. The filling defect, usually on the gastric walls, leaves the curvature regular and pliant. 3. Rugae surrounding the tumor are more nearly normal in their arrangement and distribution than in inflammatory or malignant conditions. 4. Minimal disturbance occurs in peristalsis and retention is uncommon except when the lesion is near the pylorus. 5. Absence of niche is noted and there is no incisura or other evidence of spasm. 6. Rarely is a tumor sufficiently large to be palpated. 7. The column of barium splits as it passes over the tumor. These criteria, with a few additions, still constitute the basis for the roentgenologic diagnosis of submucosal, intramural gastric tumors and with slight modification may be applied to these tumors in all portions of the alimentary tract.

Moore did not mention the characteristics of the mucosa over the tumor itself. Other authors[22,37,40] have called attention to the stretching of the mucosa and flattening of the rugae caused by the underlying mass and have likened this appearance to that of a "peeled orange" or the "face of the moon." Ulceration of the tumor also has been mentioned in many cases. Roentgenologically a central crater may be seen which is well demarcated and of varying depth, usually not more than 1 cm.[2,12,18,31]

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† Abridgment of thesis submitted by Dr. Baker to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology.
‡ Now on military leave of absence. The views expressed in this paper do not necessarily agree with those of the United States Army.
§ The Mayo Foundation is a part of the Graduate School of the University of Minnesota.

This basic picture may be altered somewhat in special situations and numerous investigators have described variations which they have seen.

Eliason and his co-workers encountered several pedunculated gastric tumors which prolapsed into the duodenum. These lesions caused a central filling defect in the duodenal bulb without disturbance to motility but with some degree of gastric retention owing to a ball-valve action. If the mass could be replaced into the stomach by manipulation, Moore's criteria of diagnosis could be used. By extension, this description may be applied to pedunculated growths in any portion of the bowel. They produce a rounded defect within the lumen which may be displaced up and down the bowel to the limits of the length of the pedicle.

Schatzki and Hawes, Harper and Tiscenco and others[1,7,13,15,23,29] were interested mainly in smooth-muscle tumors of the esophagus. These tumors present special problems in diagnosis because of the anatomic characteristics and location of the organ. They stated that in profile an abrupt, sharp angle is seen where the edge of the tumor indents the esophageal wall. Face-on the lesions are sharply outlined in the relief picture of the organ. The lumen may appear narrowed, but it is never obstructed, and the mucosa is rarely ulcerated. If the mass is large, it may be seen protruding into the mediastinum, but, whatever the size, the length of the indentation in the outline of the esophagus is equal to the greatest diameter of the tumor and equal portions are projected into the lumen and mediastinum.

When small intestinal lesions are present, they cause intestinal obstruction in about 40 per cent of the cases, usually by intussusception.[3,4] According to one of us (Good), a roentgenologic study of the condition which exists when this occurs shows that when the intussusception is approached, the opaque stream narrows until it reaches the intussuscipiens. Reflux of the opaque material then fills the space between the intussusceptum and the intussuscipiens, while the stream at the same time progresses onward into normal bowel. The cause of this condition often is not discernible, because the roentgenologic signs of the tumor are obscured by those of the intussusception and surgical intervention is necessary to reveal the true cause.

Leiomyomas and leiomyosarcomas which lie beneath the serosa of the bowel have not been written about to any great extent. Kirklin and Weber[21,38] and Carter and Laing have noted that this type of tumor is usually much larger than the submucosal type, will displace the stomach and will produce a marginal deformity of the barium shadow by either traction or pressure. Careful examination and palpation are necessary to reveal the true cause of the deformities.

All authors agree that leiomyosarcomas usually have the same roentgenographic appearance as large leiomyomas. They are, however, more likely to undergo central necrosis and excavation, so that if a tumor showing all the signs of an intramural neoplasm exhibits, in addition, multiple fistulas extending into its substance, one may strongly suspect that it is a leiomyosarcoma. Small smooth-muscle sarcomas are indistinguishable roentgenologically from benign tumors.[11,20,32,33,39]

MATERIAL

All cases of leiomyomas and leiomyosarcomas of the esophagus, stomach or intestines reported at the Mayo Clinic between 1907 and July, 1953, were carefully reviewed and pertinent roentgenologic studies, when available, were closely analyzed. In this period, 195 cases of leiomyoma and 74 cases of leiomyosarcoma were found.

Of the 269 cases, the tumors originated in the stomach in 177 (65.8 per cent), in the small intestine in 63 (23.4 per cent), in the esophagus in 20 (7.4 per cent) and in the colon in 9 (3.4 per cent). Leiomyomas were more numerous than leiomyosarcomas in a ratio of 2.64:1 and they comprised 85 per

cent of the esophageal tumors, 79 per cent of the gastric tumors, 54 per cent of the small intestinal tumors and 45 per cent of the colonic tumors.

The patients included 157 males and 112 females, ranging in age from ten to eighty years. More than 75 per cent of the patients were in the fifth, sixth and seventh decades of life.

PATHOLOGIC FINDINGS

In order to appreciate the roentgenologic changes produced, the gross pathologic characteristics of these smooth-muscle tumors must first be understood.

We have indicated previously that these lesions arise in the muscularis of the alimentary tract as a localized tumefactive overgrowth of the smooth-muscle cells. As they grow, they expand primarily in one of two directions with relation to the lumen; that is, they grow toward the lumen and come to lie in a submucosal position, or they grow away from the lumen and come to lie in a subserosal position. A few tumors expand in both directions and assume a dumbbell shape. Because of these characteristics, the tumors have been classified, with regard to their position and shape, as: (1) intramural, (2) submucosal, (3) subserosal and (4) dumbbell.[14,24,27]

The intramural lesions probably represent an early stage in the development of these tumors. They are small, benign, lie wholly within the wall of the organ and are discovered as an incidental finding at laparotomy or necropsy. They do not cause any symptoms and are too small to produce changes detectable by roentgenologic means. Fifty-one such lesions were observed in this series and will be discarded from further consideration because they lack roentgenologic significance.

In the remaining 218 cases, 126 tumors (58 per cent) were classified as submucosal, 82 (38 per cent) as subserosal and 10 (4 per cent) as dumbbell in type.

Almost any size neoplasm may be found. The submucosal type is usually smaller than the subserosal, because of the critical position of the tumor with regard to the lumen. In this position, the growth is more apt to ulcerate or cause obstruction, and therefore to be discovered before it reaches appreciable size.[10] The tumors in our series ranged in size from less than 1 to 30 cm. in diameter. Two were of the maximal diameter, 1 leiomyoma and 1 leiomyosarcoma. In general, the leiomyomas were smaller than the leiomyosarcomas. Most of these benign tumors were 5 cm. or less in diameter, whereas the majority of the malignant tumors were more than 5 cm. in their greatest dimension.

Most of these neoplasms consist of a single, firm, well-defined, rounded or lobulated mass which may be either sessile or pedunculated. Multiple growths are rare.[25] We found 23 pedunculated submucosal tumors and 9 cases in which more than 1 tumor was present.

The mucosa of the bowel is raised by, and is freely movable over, the tumor if ulceration is not present. The rugae are obliterated by the mass, but in surrounding regions they are normal, as is the mucosa itself. Ulceration may occur in gastric, colonic and small intestinal lesions, but is almost never seen in tumors of the esophagus.[27,28,30,36]

In our group of cases, ulceration occurred rather often. If we disregard the esophageal tumors, none of which were ulcerated, we find that 55 per cent of the tumors had ulcers on their mucosal surface. The ulcerations varied from 0.2 to 5 cm. in diameter, and in several tumors there were multiple pitted areas. Fistulous tracts into the tumor were described in 18 cases. Fourteen of these were leiomyosarcomas and the sinus tracts varied from 2 to 8 cm. in length. The fistulas in the 4 leiomyomas were all short, 1 to 1.5 cm., and associated with the larger tumors.

The benignancy or malignancy of these tumors can only be determined by microscopic examination, because the gross appearance is the same for both types of neoplasm.

ROENTGENOLOGIC FINDINGS

Roentgenograms in 155 cases (71 per cent) were available for study. Roentgeno-

graphically the submucosal type of tumor produces an entirely different image than does the subserosal type, and the dumbbell tumor combines some features of both. We shall discuss the roentgenologic findings, therefore, with regard to the pathologic classification of the tumors.

Submucosal Tumors. Both leiomyomas and leiomyosarcomas, in this position, produce a well-circumscribed defect in the outline of the organ which harbors them. The characteristics of the defect depend primarily on the aspect from which the tumor is viewed. When seen en face, a rounded defect completely within the outline of the organ is noted, and when viewed from one side, a semilunar type of depression is seen in the smooth outline of the organ (Fig. 1). This semilunar depression has a sharp angle at its base, which indicates that the causative mass is in the submucosal position.

If the diameter of the tumor is large, in comparison with that of the organ, its outline may be seen projecting into the surrounding tissues. When this occurs in submucosal tumors, the diameter of the mass is equal to the diameter of the defect it produces in the wall of the organ, and the afore-mentioned sharp angle is seen.

The mucosa is normal in appearance, except in instances in which it is reflected over the mass. Here the mucosal folds are flattened and disappear.

When ulceration occurs, the barium suspension will collect in the crater, so that it may be seen. These ulcerations are usually single, small, well defined and either round or linear in shape. They may, however, be multiple or assume bizarre contours and reach great size (Fig. 2).

On occasion, intussusception of small intestinal or colonic tumors will be seen. When this occurs, the typical appearance of this condition, that is, the narrowed lumen of the bowel proximal to the tumor projected within the lumen of the dilated intussuscipiens, is observed (Fig. 3*a*). A pedunculated gastric tumor may prolapse through the pylorus and appear as a rounded defect in the duodenal bulb (Fig. 3*b*). These tumors often can be replaced within the stomach by manipulation.

Roentgenoscopically, no spasm is present and peristalsis and the pliability of the wall of the bowel are not altered. The stream of barium will be seen to split as it passes over the neoplasm, but its flow is not hindered unless intussusception has occurred.

Subserosal Tumors. Small lesions of this type are usually not detected roentgenologically, especially if they are too small to be palpated or have not caused ulceration of the mucosa. Careful examination, however, may reveal a short area of stiffening in the intestinal wall. Several such lesions were observed in this series.

If mucosal ulceration is present over one of these small lesions, the task of detecting it is simplified, but the character of the ulcer is not diagnostic and again surgical means must be employed to make the final diagnosis.

About half of the subserosal tumors in our series were 5 cm. or larger in diameter. In this type, the tumor can be seen on the outside of the organ, the wall of which is deformed by traction or pressure on the area over the tumor (Fig. 4*a*). Neighboring organs are displaced by the mass, and in some instances the mass may be completely outlined by barium-filled loops of intestine (Fig. 4*b*). The deformity in the wall of the organ is formed gradually at its edge and thus differs from the abrupt angulated edge of the defect produced by submucosal lesions. The mucosal folds are flattened in only a small portion, as compared with the size of the tumor, and ulceration, if present, is seen to extend into the tumor beyond the wall of the organ (Fig. 2*c*).

Roentgenoscopically, the mass is seen to move with that portion of bowel in which it originates, and there is no spasm or alteration in pliability or peristalsis. Because of the position of the lesion, obstruction is not observed.

Dumbbell Tumors. The dumbbell tumor exhibits all of the characteristics of both of the other types. The intraluminal tume-

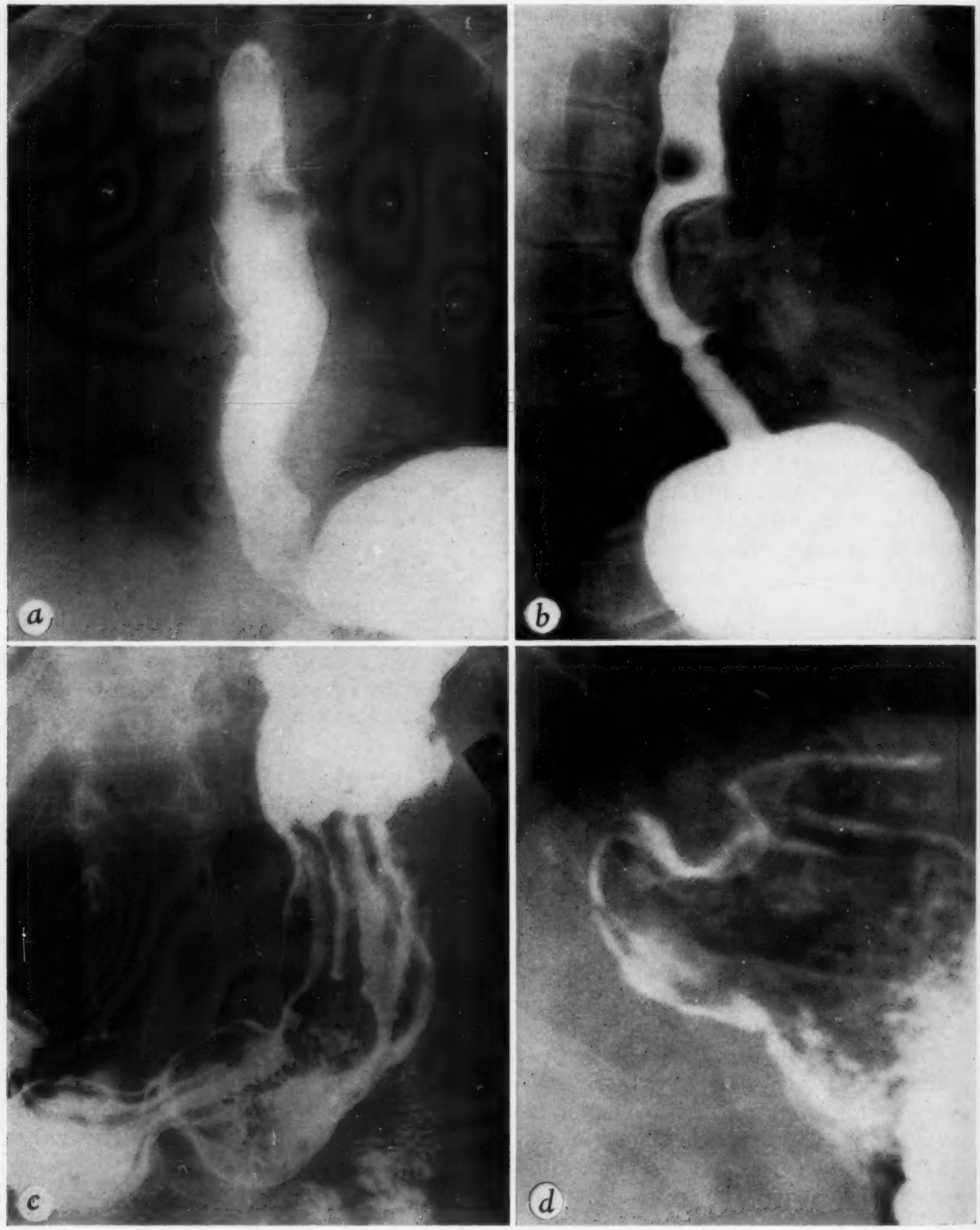

FIG. 1. *a*. Anteroposterior view of the esophagus showing two leiomyomas. The upper and smaller of the two is seen in profile, while the larger is difficult to see. *b*. Lateral view of same tumors. The smaller leiomyoma is seen en face, while the larger is outlined in profile. *c*. Leiomyoma of stomach shown en face. *d*. Leiomyoma of stomach shown in profile.

faction is seen, as well as the extraluminal mass exerting pressure on the wall of the bowel from the outside. If the subserosal portion of the tumor is small, the lesion will be indistinguishable from the submucosal type.

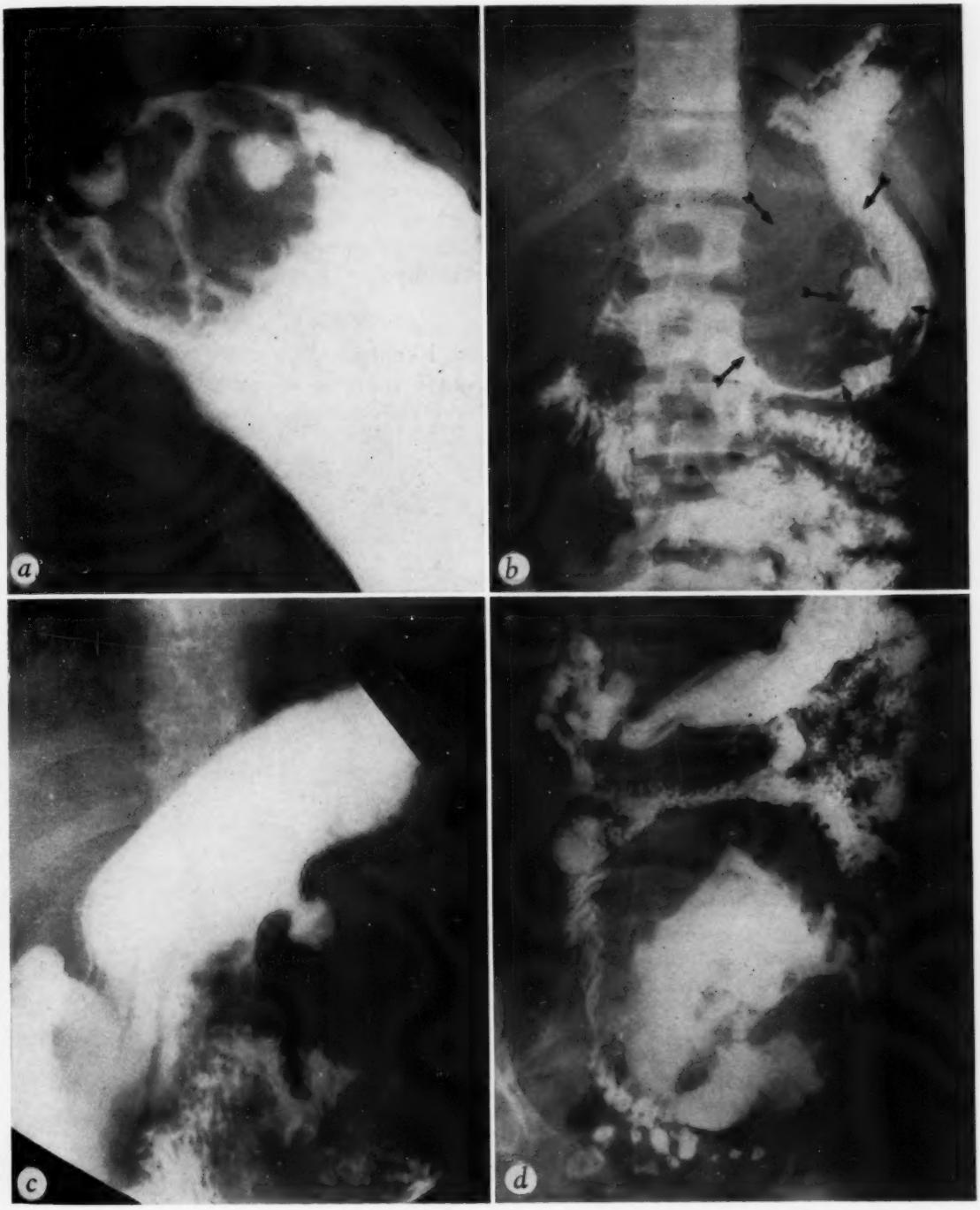

Fig. 2. *a.* Leiomyoma of cardiac portion of stomach with ulceration. *b.* Leiomyosarcoma of the stomach with ulcer crater which was 7 cm. deep. *c.* Subserosal tumor with ulcer crater extending beyond the wall of the stomach into the tumor. *d.* Large leiomyosarcoma of the small intestine with central necrosis. The deep cavity communicates with the lumen of the bowel.

Opinions regarding the malignancy or benignancy of a given lesion based on roentgenologic findings are extremely hazardous, as leiomyomas and leiomyosarcomas have much the same appearance. If one sees a tumor with large ragged ulcerations, multiple long fistulas or a cavity, the chances are three to one that the

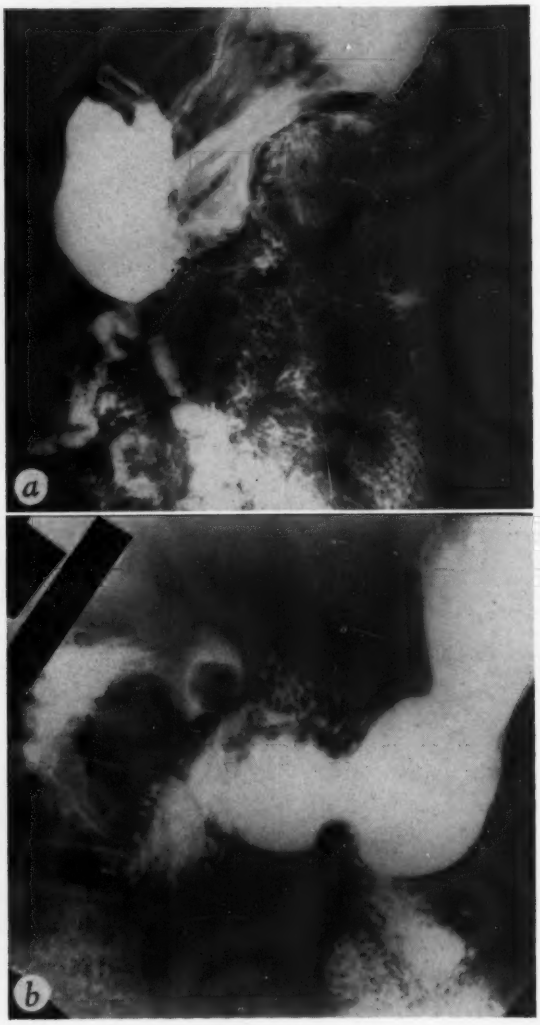

FIG. 3. *a.* Intussuscepting leiomyoma of the first portion of the jejunum. *b.* Pedunculated polypoid leiomyoma originating in the stomach and prolapsing into the duodenum.

lesion is malignant (Fig. 2*d*). Such tumors are not seen often, however, so it would seem wiser to attempt to classify any given mass as intramural in origin and as submucosal, subserosal or dumbbell in type, than to attempt to give a histopathologic diagnosis based on roentgenologic data.

DIFFERENTIAL DIAGNOSIS

In addition to leiomyomas and leiomyosarcomas, other neoplasms of the alimentary tract may, on occasion, have a similar appearance. These tumors include adenomas or polyps, carcinoma in situ, benign mesoblastic tumors, such as fibromas and neurofibromas, nonlymphoblastic sarcomas such as fibrosarcomas, neurofibrosarcoma and angiosarcoma, cysts of the wall of the small intestine and localized forms of lymphobastoma. Of all these, the leiomyomatous tumors are most numerous, except in the colon, so their presumptive diagnosis would have strong support statistically.

SUMMARY AND CONCLUSIONS

Roentgenologic examination provides the best method of locating smooth-muscle

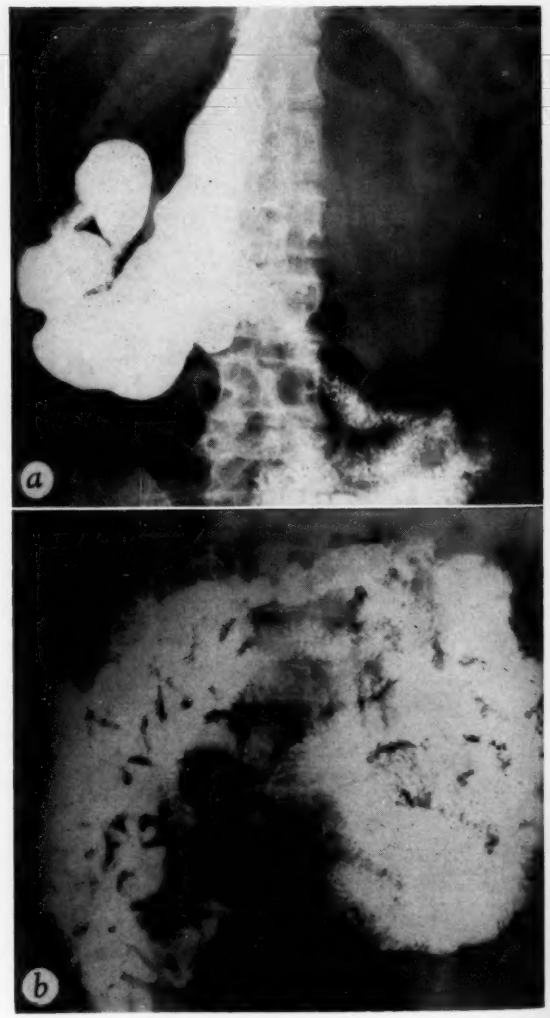

FIG. 4. *a.* Subserous leiomyosarcoma of the stomach 20 cm. in diameter. It is attached along the greater curvature. *b.* Large subserous leiomyosarcoma arising from the small intestine and displacing adjacent loops by its mass.

tumors of the alimentary tract and of determining their type. A study was made of 269 cases of such tumors reported at the Mayo Clinic between 1907 and 1953.

Smooth-muscle tumors of the alimentary tract present a roentgenologic appearance which is mainly influenced by their gross pathologic characteristics. Pathologically, they may be classified according to their position and shape as intramural, submucosal, subserosal or dumbbell type.

Intramural tumors do not alter the appearance of the tract roentgenologically.

Submucosal tumors present the following characteristic roentgenologic appearance: (1) a well-circumscribed defect in or within the outline of the wall of the organ or, if the outline of the mass is projected into the surrounding tissues, the diameter of the defect in the wall will be equal to that of the mass, and the base of that defect will appear as an abrupt, sharp angle; (2) a normal mucosa in regions adjacent to the lesion and flattened or thinned directly over it; (3) possible mucosal ulceration over the tumor; (4) normal peristalsis and pliability of the wall without signs of spasm, and (5) a split stream of opaque material where it passes over the tumor, but no evidence of obstruction to the flow unless intussusception is present.

Subserosal tumors, unless small, have a characteristic roentgenologic appearance as follows: (1) a mass may be seen outside the wall of the organ; (2) pressure or traction on the wall produces a deformity, the edges of which are formed gradually and not abruptly and sharply; (3) the mucosa is involved in only a small part as compared with the diameter of the mass, and (4) ulceration, when present, extends beyond the wall into the tumor. Other roentgenoscopic findings are the same as those seen with submucosal tumors.

Dumbbell tumors combine the roentgenologic characteristics of both the submucosal and the subserosal types.

A histopathologic diagnosis should not be attempted on the basis of roentgenologic data, but the use of such data should be confined to a description of the tumor regarding its type as intramural, submucosal, subserosal or dumbbell.

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DISCUSSION

Dr. Wallace M. Yater, Washington, D. C. The radiologist is an essential member of every medical team in all diagnostic fields, but it is the general practitioner and the internist who must exert the greatest care to "find" the patients with disease in its curable stage. In regard to the alimentary tract, every symptom must be regarded with suspicion and not merely treated symptomatically. Vague dyspepsia, pains, abnormal bowel function, and particularly bleeding, call for a gastrointestinal roentgen examination and sigmoidoscopy. If the routine gastrointestinal roentgen examination and the sigmoidoscopy fail to reveal a source of bleeding, a small intestinal roentgen examination should be carried out. The diagnostician should never forget that there is a small intestine as well as a stomach and colon.

The attending physician's greatest concern is whether a gastrointestinal lesion is malignant, and the possibility of malignancy is always present no matter how well the roentgen criteria of a tumor are established. Consequently the physician and the surgeon are never satisfied until this condition is ruled in or out by adequate microscopic examination of the tumor.

Benign tumors of the stomach are not rare. Many are not discovered, since symptoms occur in less than 50 per cent. Leiomyomas constitute

37 per cent of gastric neoplasms. Other smooth muscle tumors of the stomach are fibromyomas, myomas and adenomyomas. Clinical behavior depends on a tendency to ulcerate, bleed, or undergo malignant degeneration. Near the orifices symptoms are quite common, esophageal in nature if near the cardia, ulcer-like or obstructive if near the pylorus. When projecting into the stomach they are more apt to provoke symptoms than if growing into the peritoneal cavity. Usually exogastric tumors are asymptomatic until they achieve great size. A most important clinical feature of benign tumors is massive hemorrhage into the stomach, but continuous oozing of blood may occur, and therefore any case of unexplained anemia, either hypochromic or of a pernicious anemia type, should call for investigation of the gastrointestinal tract. Gastroscopy is of value in the differential diagnosis. Excision of a benign tumor is always indicated and gastric resection if malignancy cannot be excluded.

In the small intestine benign tumors are found in 0.16 per cent of necropsies. Adenomas are most frequent, then leiomyomas. Seven per cent of the former and 20 per cent of the latter become malignant. The duodenum and ileum are the most common sites for benign tumors, but myomas are most common in the ileum and least common in the duodenum. The intraluminal type is more likely to cause intussusception; the extraluminal is most often malignant and causes death by metastasis, hemorrhage or perforation. In leiomyomas massive hemorrhage is rather frequent and may prove fatal. A palpable mass is not rare in the subserous variety. Leiomyosarcomas tend to grow outward, undergo necrosis and bleed internally, and often there is a palpable mass.

Benign tumors in the esophagus are relatively rare. Dysphagia is common, and hemorrhage may occur.

These tumors are rare in the colon. They may cause bleeding, intussusception, diarrhea, vague distress and a mass, all nonspecific symptoms as with other tumors of the bowel.

Drs. Baker and Good are to be congratulated on such an excellent roentgenologic study of the subject, and I am sure we have all profited by the presentation of this paper.

Dr. Good (closing). As Dr. Baker told you, this material was derived from the files of tissues preserved in our sections of pathologic anatomy and surgical pathology. We did not make an attempt to discover the relative accuracy of the radiologist as to diagnosis. What we were interested in were the roentgenologic manifestations of the particular tumors in question.

I may, however, interpolate something about roentgenologic diagnosis: I am sure you all recognize the fact that these lesions are much more easily seen roentgenologically in the esophagus and stomach than they are in the small intestine and (because they are rare) in the large intestine. In the small intestine, a tumor has to assume some size before it can be recognized by the radiologist, and it should have an intraluminal component. Therefore, the submucosal and dumbbell tumors are much more easily discovered roentgenologically than are the subserosal tumors. The subserous variety, when small, are always missed, and in our experience that has been true.

Even when the patient had symptoms warranting the probability of such a diagnosis, and sometimes when we were very certain that the patient must have had such a tumor, we were unable to find it.

I should like to make another point. This study by Dr. Baker shows very well that the roentgenologic manifestations of a particular type of tumor in the alimentary tract are the same, no matter what portion of the alimentary tract is studied. These tumors look the same in the esophagus as they do in the small intestine and in the stomach. I think we sometimes forget this important consideration.

Another point I should like you to remember is that in most instances—not always—the leiomyoma and leiomyosarcoma can be distinguished from the tumor which arises from the mucous membrane, and that any tumor which arises from the mucous membrane must have, in the mind of the radiologist, the potential of malignancy. The malignant potential of leiomyomas and leiomyosarcomas is much less than that of carcinoma. For this reason, it is well to attempt to distinguish these tumors from others which arise from the mucous membrane.

RETENTION OF THE OPAQUE MEDIUM DURING CHOLECYSTOGRAPHY

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THE detection of opaque material in the stomach during cholecystography is of considerable significance. Little attention has been paid to this finding with few articles on the subject appearing in the literature.[1]

The roentgen diagnosis of biliary tract disease has been substantially improved by the newer cholecystographic opaque media. Telepaque, with a 67 per cent iodine content, appears to be the most useful at present, supplanting priodax which has 51 per cent iodine. About ten years ago, priodax proved superior to the then long used tetraiodophenolphthalein. Teridax is also in fairly wide use today.

After oral administration, both telepaque and priodax are absorbed from the small intestine within a few hours. Gallbladder opacification can be recognized as early as two hours following ingestion of telepaque.[3] These contrast media are carried to the liver and excreted rapidly through the bile, thus entering and opacifying the biliary tract. Priodax is reabsorbed repeatedly from the intestine and appears in the gallbladder in decreasing amounts and diminishing density for from three to five days. About 50 per cent of the ingested priodax is excreted by the kidneys in twenty-four hours.[2] Telepaque, however, is not appreciably reabsorbed, and up to only 5 per cent is excreted by the kidneys.[3] Consequently, considerable opacification is usually seen scattered throughout the colon during cholecystography. Because of its higher radiopacity, telepaque can opacify the common duct after fat stimulation of the gallbladder. This occurs in over half the cases.[3] More striking is the possibility of opacifying the common duct in patients without a gallbladder, using a larger dosage of oral telepaque.[4]

Cholecystograms are generally made ten to fourteen hours after oral administration of the contrast material. This time interval is more than sufficient to allow complete gastric emptying, even if some nausea has occurred. Any opacification in the stomach or duodenal bulb is therefore distinctly abnormal and significant and the roentgenologist should then be alerted to the probability of upper gastrointestinal disease.

The following brief case reports illustrate the significance of retained gastric contrast medium as detected during cholecystography.

REPORT OF CASES

Case I. B.D., a woman, aged sixty-three, was hospitalized with a clinical diagnosis of suspected biliary tract disease. She had suffered epigastric discomfort for three months, which was accompanied by a full feeling after eating and, at times, pain in the region of the scapula. She was occasionally nauseated, but never vomited. The symptoms had not increased in severity since their onset, but there had been a slight weight loss. The rest of the history was noncontributory. The physical examination and laboratory studies uncovered no significant abnormalities.

Cholecystography revealed a normal gallbladder shadow without calculi. Small amounts of contrast medium were observed in the lower end of the esophagus and gastric antrum. An immediate investigation of the esophagus disclosed marked dilatation with narrowing at its lower end (Fig. 1). Although a carcinoma of the lower end of the esophagus could not be excluded, the roentgen diagnosis was probable achalasia. Esophagoscopy confirmed this diagnosis.

Case II. J.G., a man, aged fifty-three, had been suffering for about six months from indigestion with right upper quadrant pain, belching and some loss of appetite. A physician had

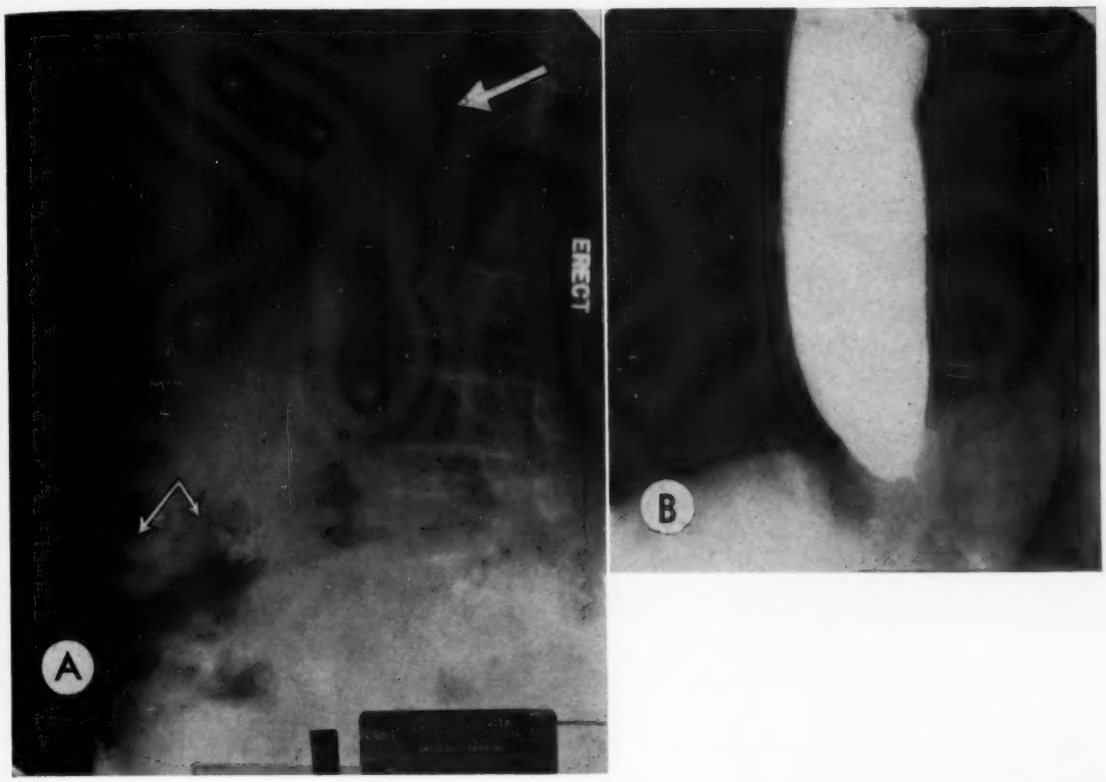

Fig. 1. Case 1. (*A*) Double arrow points to gallbladder shadow and opacities in lower end of stomach. Upper arrow shows opacity in lower esophagus. The achalasia of the esophagus is clearly seen in (*B*).

diagnosed gallbladder disease, but there had been little improvement by medical treatment. Physical examination was negative except for some right upper quadrant tenderness.

The gallbladder proved normal on cholecystography. However, some opaque material was observed in the lower portion of the stomach, and an upper gastrointestinal study was advised. This disclosed a huge prepyloric ulcer, considered probably benign (Fig. 2). Under medical treatment, all symptoms abated, and the ulcer rapidly diminished in size.

Case III. A.W., a man, aged sixty-six, entered the hospital because of abdominal pain. This had started about two weeks before admission, was located in the right upper quadrant, and at times seemed worse after meals. The pain radiated to the back and considerable eructation accompanied the discomfort. His appetite was normal and no nausea had occurred. There were no bowel disturbances. His past history included vague indigestion for fifteen years, with occasional attacks of pain in the lower abdomen and right upper quadrant Physical examination uncovered some tenderness on the right side of the abdomen; the rest of the examination, including the usual chemistry and hematological studies, was not significant. The clinical diagnosis was biliary tract disease.

The cholecystogram revealed a normal gallbladder shadow, without calculi. Considerable contrast medium was noted in the stomach, raising strong suspicion of abnormality in the stomach or duodenum. The barium meal study disclosed a constant pyloroduodenal deformity with obliteration of the pyloric canal (Fig. 3). Although initially there was nonopaque residue in the stomach, gastric emptying was surprisingly complete at five hours. The findings were interpreted as chronic pyloroduodenal ulcer and this was confirmed at surgery.

Case IV. W.Y., a man, aged forty-five, was referred for cholecystography. The presenting complaints were right upper quadrant pain and some weight loss. He had been well until two

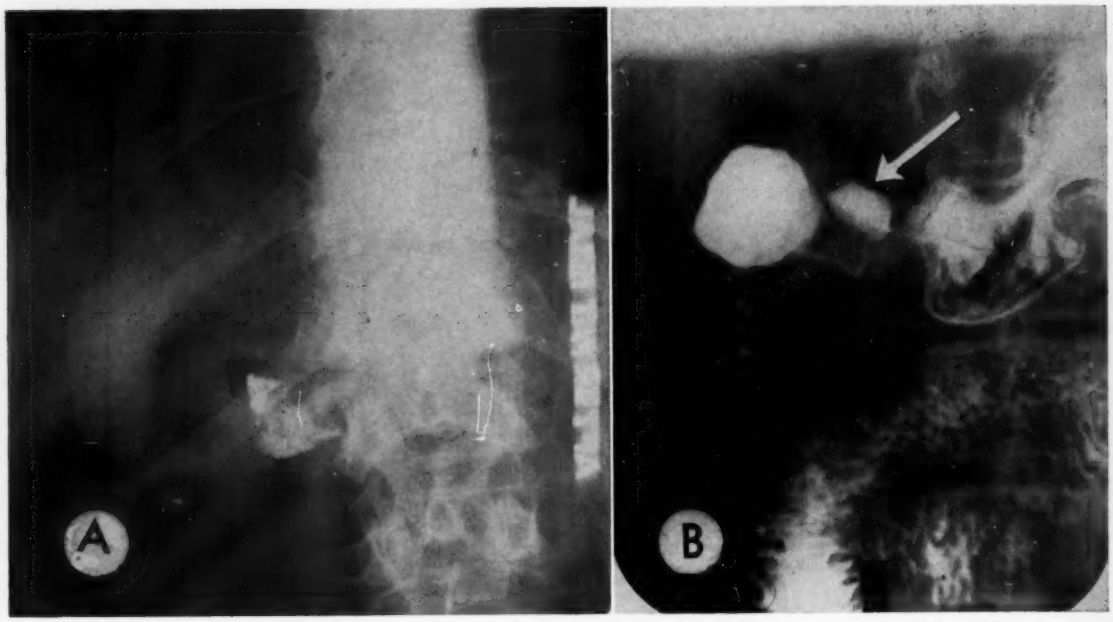

Fig. 2. Case II. The small collection of opacities in (*A*) were in the stomach and duodenal bulb. The arrow in (*B*) points to the large prepyloric ulcer.

months before, when he developed occasional pain in his right lower chest and right upper quadrant, with frequent radiation to his back. This became more frequent and he began to vomit at night to obtain relief. There was no heartburn but he avoided food and had lost about 20 pounds in weight within the last two months.

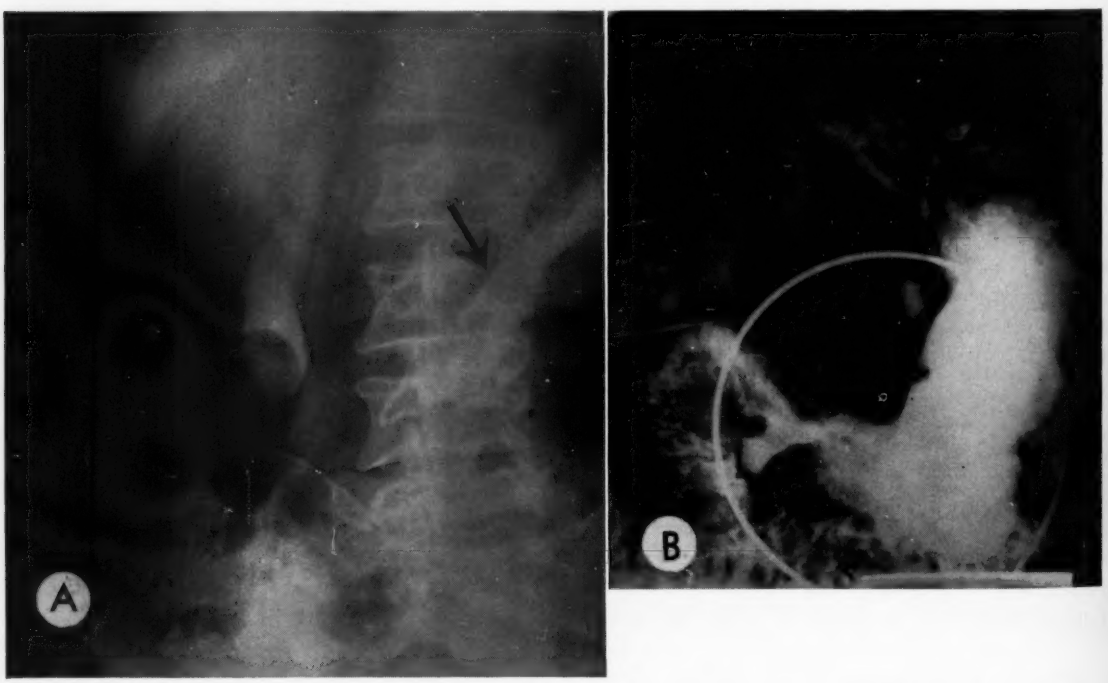

Fig. 3. Case III. The arrow in (*A*) points to gastric opacities. (*B*) shows deformed pyloroduodenal area.

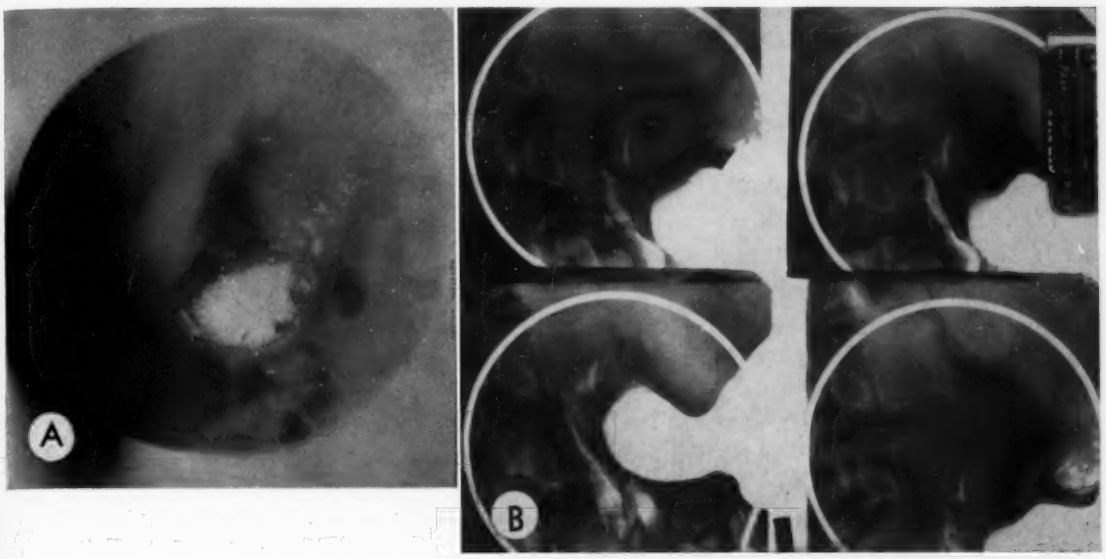

Fig. 4. Case iv. The gastric opacities in (*A*) might be mistaken for colonic contrast medium. The constant pyloroduodenal deformity is seen in (*B*).

The cholecystogram showed a normal gallbladder shadow, without calculi. Opaque material was noted in the stomach. The suggested upper gastrointestinal study revealed a marked deformity at the pyloroduodenal area; there was some nonopaque residue in the stomach. Gastric emptying was complete at five hours (Fig. 4). The roentgen findings were interpreted as probable benign peptic ulcer, although malignancy could not be excluded.

Case v. J.C., a man, aged sixty-nine, was referred for oral cholecystography. His chief complaint was belching with a full feeling in the abdomen after meals. There was a burning sensation in the sternal area, but this was not ordinarily related to food. There was no abdominal pain. His past history included a coronary occlusion seventeen years previously. There was also a previous gallbladder roentgen study (about five years before) which was said to be suspicious of disease.

Roentgenograms of the gallbladder showed a rather faint gallbladder shadow without calculi.

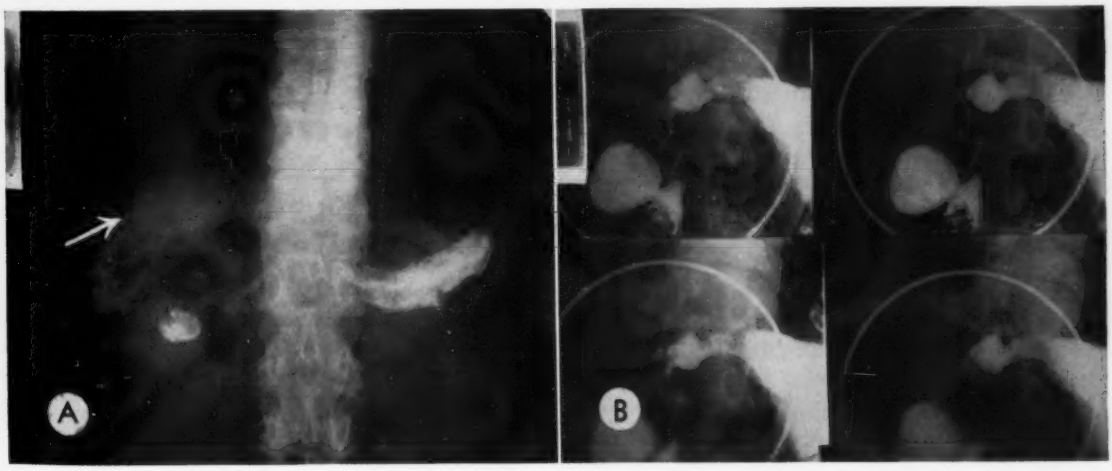

Fig. 5. Case v. Arrow in (*A*) points to rather faint gallbladder shadow. The gastric opacities and opaque medium in the duodenal diverticulum are also seen. (*B*) illustrates the duodenal deformity and diverticulum.

Some opaque material was observed in the stomach and there was also a round, opaque collection below the gallbladder. The barium meal study showed a deformed bulb with an ulcer crater and a large duodenal diverticulum which corresponded to the round opacity described on the gallbladder films (Fig. 5). Gastric emptying was not delayed.

DISCUSSION

Ordinarily, roentgen studies of the gallbladder are made ten to fourteen hours after the oral ingestion of the contrast medium. Opaque residue observed in the stomach at that time is distinctly abnormal, and is probably more significant than six hour barium residue in the upper gastrointestinal study. Attention has been directed to the significance of this gastric residue in cholecystography by Gottlieb and Beranbaum.[1]

A word is in order concerning the recognition of this retention. Commonly, the cholecystographic studies consist entirely of spot or local films of the gallbladder area. On such studies, a small opaque collection in the distal part of the stomach could be mistaken for colonic opacities. With telepaque, now widely used, these latter are the rule. The roentgenologist is wont to ignore them and concentrate his attention on the gallbladder shadow. In our cases, the amount of opaque residue was generally small.

It is interesting that barium studies in Cases III, IV and V showed no significant delay in gastric emptying. Perhaps the gallbladder contrast media delay gastric emptying to some degree, especially in the presence of inflammatory gastroduodenal lesions. This is not entirely surprising. It is well known that the inert barium meal leaves the stomach more rapidly than food, even in cases of delayed emptying, but the gallbladder contrast media are not chemically inert. The gallbladder was opacified to a normal degree in 4 instances; in the fifth, the density was below normal. The retention of contrast medium in the lower end of the esophagus for fourteen hours was a most unusual finding (Case I).

In all 5 reported cases, biliary tract disease was suspected. The retained gastric contrast medium indicated the strong probability of upper gastrointestinal pathology, which was then verified by barium studies. It must be conceded that the existing disease would probably have been found without this clue, since the normal gallbladder findings would have suggested further studies. However, in office radiology, not infrequently the referring physician may accept the normal gallbladder as confirmation of a functional diagnosis and seek no further. Moreover, a poor or absent gallbladder shadow due to insufficiently absorbed opaque medium might be taken as evidence of gallbladder disease if the gastric opacity is overlooked.

In our series, there were 3 patients with duodenal ulcer, 1 with gastric ulcer and 1 with achalasia of the esophagus. The reported series of Gottlieb and Beranbaum[1] consisted of 7 cases with gastric residue. In 5 patients disease was uncovered; 3 had duodenal ulcers, 1 a gastric ulcer, and in 1 a carcinoma of the stomach was found. Of these 5 patients, 2 failed to show opacification of the gallbladder. The gastric retention was disregarded in 1 of these patients with a nonvisualized gallbladder, and surgery performed for biliary tract disease revealed a perforating duodenal ulcer and a normal gallbladder. Two patients of their series had nonvisualized gallbladders with some gastric residue, in whom barium studies showed no upper gastrointestinal disease. Only 1 of these proved to have gallbladder pathology.

Though not included in our case reports, we also encountered 2 patients with gastric retention at cholecystography, but without demonstrable disease of the stomach or duodenum. Careful questioning of one of these patients elicited gross disregard of instructions for cholecystography; a repeat study was normal. The delay of gastric emptying in the other case could not be

explained; perhaps temporary antral spasm could be postulated.[1]

SUMMARY AND CONCLUSIONS

1. Five cases are presented, initially suspected of gallbladder disease. Retained gallbladder opaque medium in the stomach (and lower esophagus in one patient) called attention to possible upper gastrointestinal pathology which was confirmed by barium studies.

2. In three patients, duodenal ulcer was uncovered and in one, a gastric ulcer; achalasia of the esophagus was found in one patient.

3. Opacities in the stomach at the time of cholecystography represent at least ten hours' retention, becoming more significant, therefore, than six hour barium retention. Generally, this gastric residue will prove to be due to upper gastrointestinal disease. There may be no six hour barium retention.

4. The radiologist should carefully scrutinize cholecystograms for evidence of gastric opacities. Small amounts of opaque material in the lower end of the stomach could be overlooked or mistaken for colonic opacities.

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FURTHER CONSIDERATION OF DEATHS AND UNFAVORABLE SEQUELAE FOLLOWING THE ADMINISTRATION OF CONTRAST MEDIA IN UROGRAPHY IN THE UNITED STATES*

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IN 1942 a survey of deaths and unfavorable sequelae following the administration of contrast media in urographic studies was made.[24] Since that time, the use of contrast media in roentgen diagnosis has been extended and many excellent articles have been written on their various applications. We have now made another survey in an effort to further evaluate the hazards concerned with the use of urographic media in the United States.

There was a total of 1,371 replies to the 3,300 questionnaires sent to the membership of the American College of Radiology. This represents a response rate of 41.5 per dent (Table I). Of the 1,371 replies, 99 were discarded because they did not contain any pertinent data. For the most part, these were replies stating either that the doctor was no longer in practice, did only therapeutic radiology, or did not do urography. Of the remaining 1,272, there were 23 which did not give complete information, leaving 1,249 which were satisfactory for complete analysis (Table II).

TABLE I

UROGRAPHIC (CONTRAST MEDIA) SURVEY

Total number of questionnaires sent to the membership of the American College of Radiology asking for information regarding intravenous urographic studies	3,300
Total replies received	1,371
Per cent response to questionnaires	41.5

CONTRAST MEDIA USED

A total of 3,831,850 urograms was reported based on estimates furnished by those returning the questionnaires. The details as to the contrast media used in these urographic studies are shown in Table III. It should be noted that the two most commonly used media—diodrast and neo-iopax—accounted for approximately 94 per cent of the urinary tract studies.

QUANTITY AND CONCENTRATION OF CONTRAST MEDIA

The quantity of contrast media injected in the average sized adult was reported as 20 to 30 cc. The concentration of opaque medium was in almost every instance that supplied by the manufacturer (Tables IV and V). With the exception of urokon sodium, where the demand for 70 per cent concentration is relatively high, the higher concentrations of the media were used rarely in intravenous urography.

NONFATAL REACTIONS

Local reactions reported at the site of injection were almost entirely limited to cases in which there was extravasation of the contrast medium at the time of injection.

Venospasm proximal to the site of injection was not rare. Although the data did not permit statistical analysis because of indefinite or incomplete replies, it was our impression that pain from venospasm was more common with the use of neo-iopax

* From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania. Presented before the Seventh International Congress of Radiology, Copenhagen, Denmark, July 19–25, 1953.

Table II

STATISTICAL ANALYSIS OF RESPONSE TO UROGRAPHIC QUESTIONNAIRES SENT TO MEMBERSHIP OF THE AMERICAN COLLEGE OF RADIOLOGY

	Number	
Total replies to questionnaire	1,371	100.0
Replies discarded (no pertinent data)	99	7.2
Replies usable in whole or in part	1,272	92.8
Replies incomplete (usable in part)	23	1.7
Replies satisfactory for complete analysis	1,249	91.1

than with diodrast, and that rapid injection was less often accompanied by pain from venospasm than was the slow injection.

The data available did not permit numerical analysis of the number or degree of generalized reactions. Urticaria, angioneurotic edema (particularly periorbital and laryngeal edema), and flushing were the commonly reported allergic symptoms.

An acute reaction with syncope, marked hypotension, complete cessation of respirations, cyanosis, and marked weakness or complete absence of perceptible cardiac action was the most common type of reaction which appeared to threaten life.

Table III

CONTRAST MEDIA USED IN INTRAVENOUS UROGRAPHY, SURVEY MEMBERSHIP AMERICAN COLLEGE OF RADIOLOGY (1942 TO 1952 INCL.)

Name of Medium	Number of Patients Examined	Per Cent of Total Cases
Diodrast	2,551,493	66.6
Neo-iopax	1,041,530	27.2
Urokon sodium	175,722	4.6
Skiodan	7,591	0.2
Hippuran	2,746	
Ditopax	543	
Iopax	143	
Diodone	30	
Media not specified	52,052	1.4
TOTALS	3,831,850	100.0

These symptoms, when present, usually appeared shortly after or even during the injection and were variously attributed by the reporting physicians to peripheral vascular collapse and to primary cardiac phenomena, such as heartblock.

Other generalized reactions, mentioned less frequently, included acute pulmonary edema, convulsions, carpopedal spasm, headache, and chills.

FATAL REACTIONS

The analysis of reactions following intravenous urography in the present survey showed that 31 deaths had occurred in addition to those already reported in the literature. The deaths were divided into three groups: *immediate*, *delayed* and *indeterminate* (Table VI).

The *immediate* death was defined as one in which the reaction developed during the urographic examination and was followed by death. Twenty-five immediate deaths were found in this study. The *delayed* deaths were those deaths occurring in patients who had no immediate reaction or the reaction developed over one hour after the urographic examination, with death occurring later. There were 3 deaths in this category. The *indeterminate* deaths included those in whom insufficient data were available for evaluation. Three deaths were included as indeterminate.

IMMEDIATE DEATHS

In the previous survey,[24] 661,800 urographic examinations were reported and there were 26 deaths. Of these, 10 were classified as "immediate." In the present study of 3,831,850 urographic examinations, 25 of the 31 reported deaths were classified as "immediate." Thus, one observes that the percentage of deaths is lower in the recent survey than it was in 1942 (Table VII).

CASE REPORTS

The full case reports of the immediate deaths are as follows:

TABLE IV

DOSAGE FORMS OF COMMONLY USED INTRAVENOUS UROGRAPHIC MEDIA

Name of Medium	Concentration	Dosages Supplied
DIODRAST		
(*Winthrop-Stearns, Inc.*)		
Solution diodrast	35% w/v	10 cc., 20 cc., 30 cc.
Concentrated solution diodrast*	70% w/v	20 cc., 50 cc.
Diodrast compound		20 cc.
NEO-IOPAX		
(*Schering Corporation*)		
Solution neo-iopax	50%	10 cc., 20 cc., 30 cc.
Solution neo-iopax*	75%	10 cc., 20 cc., 30 cc.
UROKON SODIUM		
(*Mallinckrodt Chemical Works*)		
Solution urokon sodium	30%	25 cc.
Solution urokon sodium	70%	25 cc.
SKIODAN		
(*Winthrop-Stearns, Inc.*)		
Powder skiodan*		20 gm.
Solution skiodan sodium*	20%	50 cc.
Solution skiodan sodium	40%	50 cc., 100 cc.
Tablets skiodan*		1 gm.
HIPPURAN		
(*Mallinckrodt Chemical Works*)		
Crystals hippuran		12 gm., 100 gm., 500 gm.
Solution hippuran	48%	25 cc.

* Not primarily for intravenous urography.

CASE 1. Reported through the courtesy of Drs. H. S. P., R. V. M., and J. B. J.

A white woman, aged twenty-four, the wife of an intern, was referred to the Department of Radiology as an outpatient in April, 1947. A week before the urographic examination she had had intermittent cramp-like epigastric pain associated with nausea and vomiting. A survey roentgenogram of the abdomen had shown a probable phlebolith on the left side within the bony pelvis. The referring physician wished to definitely exclude a left ureteral calculus.

The patient had had mouth ulcers off and on for about five or six years and a food allergy had been suspected, but she had been unable to associate the ulcers with any particular food. She had had occasional attacks of sneezing but these had not been particularly severe. Her mother and a maternal uncle had had hay fever, but there was no other allergic history. Cholecystography had been performed three days before examination with no untoward reaction.

On the morning of the urinary tract examination, 2 cc. of diodrast was placed under the patient's tongue and a few minutes later, 1 cc. of the contrast medium was injected intravenously. There was no reaction. Several minutes later, the main intravenous injection of diodrast was started, and after 5 cc. had been injected, the patient complained of an intense desire to urinate; she became dyspneic and cyanotic and suffered a convulsion. Attempts at resuscitation, including oxygen by positive pressure, intracardiac stimulants and artificial respiration, were futile and she died about twenty minutes after the injection. It was thought that death was due to massive pulmonary edema. An autopsy was not performed.

Comment. The patient was a healthy young woman and death was undoubtedly due to the injected diodrast.

CASE 2. Reported through the courtesy of Drs. E. F. Z. and R. V. T.

A white man, aged sixty-five, who had previously had an abdominoperineal resection for carcinoma of the rectum, entered the hospital with symptoms of urinary obstruction. He gave no history of idiosyncrasy to drugs or to food. A conjunctival sensitivity test was nega-

TABLE V

CONTRAST MEDIA AVAILABLE FOR INTRAVENOUS UROGRAPHY

Medium	Diodrast*	Neo-Iopax†	Urokon Sodium‡	Skiodan*	Hippuran‡
Generic name	Iodopyracet	Sodium iodomethamate	Sodium acetrizoate	Methiodal sodium	Iodohippurate sodium
Chemical name	35-diiodo-4-pyridone N-acetic acid diethanolamine	Disodium N-methyl, 3,5-diiodo-cheldamate	Sodium 3-acetylamino-2,4,6-triiodobenzoate	Sodium iodomethanesulfonate	Sodium o-iodohippurate dihyrated
Per cent iodine (dry compound)	49.8	51.5	65.8	52	39%
Concentration of drug used for intravenous urography (aqueous solution)	35%	35%	35% and 70%	20% to 40%	48%
Synonyms	Diatrast Diodone Dijodin Iopyracil Ioduron Neo-methiodal Neo-skiodan Neo-tenebryl Nosydrast Nosylan Oparenol Perabrodil Per-radiographol Perurdil Pyelosil Pylumbrin Rayopake Umbradil Uriodon Vasiodone 3203-RP	D-40 Iodoxyl Lumoxyd Neo-iopax R Neo-iopax sodium Pyelectan Uropac Uroselectan B Urotrast Urumbrin		Abrodil Diagnorenol Iodairal Intron Radiographol Tenebryl	

* Trademark, Winthrop-Stearns, Inc.
† Trademark, Schering Corporation.
‡ Trademark, Mallinckrodt Chemical Works.

tive. One cubic centimeter of 35 per cent diodrast was then injected intravenously and, when there was no reaction, the remainder of the 30 cc. ampule was injected. The injection of the entire 30 cc. required about 10 minutes. Immediately after completion of the injection the patient developed difficulty in breathing, became agitated and restless and went into shock. Despite the intravenous injection of adrenalin, administration of oxygen and artificial respiration, he rapidly became cyanotic and stuporous and was pronounced dead fifteen minutes after the injection of the opaque medium.

The postmortem examination showed tremendous dilatation of both lungs and it was said that the condition resembled an acute anaphylactoid reaction. No other pertinent findings were noted.

Comment. It was the opinion of those who saw this patient that death was due to sensitivity to diodrast.

CASE 3. Reported through the courtesy of Dr. D. S.

A colored man, aged fifty-six, was admitted to the hospital on April 24, 1949, because of increasing attacks of asthma in the immediate period preceding admission. He had had attacks of asthma repeatedly during the previous fifteen to twenty years. For a period of two to three months prior to admission he had had night sweats and had also lost an indeterminate amount of weight. He had had nocturia 3 to 4 times nightly and other symptoms of "kidney trouble" for a number of years. He had also been told that he had high blood pressure. He appeared chronically ill, and asthmatic rales

TABLE VI

DEATHS FOLLOWING REACTION TO CONTRAST MEDIA IN INTRAVENOUS UROGRAPHY

Deaths	Patients
Immediate	25
Delayed	3
Indeterminate	3
TOTAL	31

were heard throughout both lung fields. The blood pressure was 145–130/85. The liver was enlarged and there was 1 plus edema of the extremities. The tentative diagnosis was "hypertensive cardiovascular disease with failure." A roentgenogram of the chest showed slight cardiac enlargement. Laboratory reports included slight albuminuria and a few hyaline and finely granular casts. The Kahn test was positive.

The patient was placed on a cardiac decompensation regimen and he improved rapidly. About two weeks after admission, an intravenous urogram was requested. A preliminary conjunctival sensitivity test gave no reaction. Thirty cubic centimeters of 35 per cent diodrast solution were then administered intravenously over a period of four minutes. Two minutes after completion of the injection, the patient suddenly sat up, speechless and dyspneic. Administration of adrenalin, artificial respiration and later oxygen under positive pressure were of no avail and death occurred three to four minutes after the injection. Autopsy showed a patchy pulmonary atelectasis, myocardial hypertrophy (left ventricle), arteriolonephrosclerosis and atherosclerosis.

Comment. The pathologist commented as follows: "Although this patient did not show allergic response to diodrast when the material was placed in the conjunctiva, he responded with acute bronchial asthma when it was injected intravenously. He died in status asthmaticus. The changes in the bronchi show four of the five classical histologic signs of primary bronchial asthma."

CASE 4. Reported through the courtesy of Dr. F. J. R.[25]

A white woman, aged fifty-five, was admitted to the hospital on November 7, 1950, complaining of pain in the right lower flank which began an hour before admission and just before eating lunch. She was nauseated and had vomited several times. Physical examination was essentially negative. Uncatheterized urine contained 2 per cent leukocytes, 3 per cent red blood cells and 1 per cent protein. Roentgenograms of the abdomen disclosed no urinary calculi.

The following day intravenous urography was started. No sensitivity tests were done and no allergies were known to the patient. Twenty cubic centimeters of 50 per cent neo-iopax were injected intravenously in about sixty seconds. About forty-five seconds after the injection the patient turned blue, stopped breathing and became pulseless. The heart sounds could not be heard and the blood pressure was unobtainable. Adrenalin was injected intravenously and artificial respiration begun without change in the patient's condition. The chest was then opened through a curved anterior cardiac incision. The fifth and sixth costal cartilages were cut and spread apart. Cardiac massage was started approximately seven minutes following the injection of the neo-iopax. At the same time intratracheal positive pressure oxygen was administered. After about twenty minutes of cardiac massage, together with the intracardiac injection of adrenalin and pronestyl, the heart began to beat spontaneously and the blood pressure rose to 130/60. Spontaneous respiration commenced shortly after this.

When it became apparent that regular cardiac action and respiration had been re-established, the thoracic incision was closed and the patient moved from the roentgenographic table to her bed. At this time the blood pressure varied from 160/110 to 120/30. The patient never regained consciousness, although she responded slightly to direction. Her respirations were labored and became more irregular. Oxygen administration along with bronchoscopic aspiration led to little improvement in her condition and she died thirty-six hours after the cardiac arrest.

An autopsy revealed the chief cause of death to be extensive anoxic changes throughout the brain. Other associated findings of interest included (a) marked fatty infiltration of the liver, (b) lower nephron nephrosis, (c) hemorrhagic pulmonary edema, (d) acute cardiac dilatation.

Comment. In our opinion, death in this patient was due to a sensitivity to neo-iopax.

Case 5. Reported through the courtesy of Dr. J. A. E.

A white man, aged sixty-four, was admitted to the hospital because of jaundice. Four months before, he had been admitted because of a bleeding ulcer and had had a gastric resection. Ten days before the present admission he had had symptoms of grippe but improved rapidly on bed-rest. However, five days before admission he became jaundiced, noted light stools and dark urine and also soreness in the left costovertebral angle. The physical examination showed moderate jaundice but he was otherwise in good health. The liver was markedly enlarged and quite tender. Laboratory studies showed bile in the stools. Liver function tests indicated a rather severe degree of liver damage.

Because the survey roentgenogram of the abdomen showed a large right renal shadow with calcification, an intravenous urogram was requested. The history did not mention whether or not the patient had any allergies although it was stated that his father died of "asthma." There was no record of a sensitivity test. A few minutes after the injection of 20 cc. of diodrast 35 per cent, the patient began to feel pressure in the chest, had difficulty in breathing, and died about two and one-half hours after the injection.

The postmortem examination showed: (1) hepatitis, diffuse with focal necrosis; dilatation of the common duct; (2) arteriolonephrosclerosis (hypertension); (3) cyst right kidney with calcification of wall; (4) arteriosclerosis, aorta and renal arteries, marked; coronary and smaller renal arteries, moderate; (5) absence, distal half of stomach; (6) pleurisy, fibrous right; (7) polyps, colon, multiple; (8) lungs, acute massive edema; (9) spleen, hyperplasia of red pulp with softening.

It was said that the postmortem examination failed to adequately explain the liver disease in this case. The jaundice and clinical evidence of liver damage preceded the terminal episode and the focal areas of absence of liver cells probably were of several week's duration. This patient while clinically showing evidence of jaundice and moderately severe liver disease was not chronically ill. He was ambulant and required no nursing care.

Comment. In spite of severe liver damage, the patient's death was probably directly due to diodrast.

Case 6. Reported through the courtesy of Dr. J. A. E.

A white man, aged seventy, was admitted to the Department of Radiology as an outpatient because of frequency, nocturia, and weak urinary stream. He had had a suprapubic prostatectomy two years previously. The record did not state whether the patient was questioned regarding allergy. The examination showed moderate emphysema and also slight liver enlargement. A sensitivity test (cutaneous) did not give a local reaction. The injection of 35 per cent diodrast was begun but the first few cubic centimeters extravasated and a second vein had to be used. Ten minutes following the injection of 20 cc. of the medium, the patient suddenly became dyspneic, cyanotic, pulseless and the cardiac sounds were not audible. He was given vigorous supportive measures, following which he roused slightly and complained of lower abdominal pain. However, he developed pulmonary edema and died quickly. There was no postmortem examination.

Comment. We believe that this patient died from the injection of diodrast.

Case 7. Reported through the courtesy of Dr. E. M. S.

A white woman, aged thiry-eight, was referred for intravenous urography because of burning and frequency of urination and hematuria. The clinical diagnosis was subsiding subacute urethritis. There was no history of allergy. A sensitivity test was not made. The intravenous injection of 35 per cent diodrast was begun. After injection of about 5 cc. of the medium, the patient felt warm but was otherwise asymptomatic. After 18 cc. had been injected, the patient could not speak but within a few minutes she was feeling better and was able to talk. She then began to shake and twitch, had groaning respirations and became disoriented. The blood pressure was 140/70 and the pulse and color were good. Three-quarters of an hour later she became irresponsive and was removed to the hospital. She remained comatose with stertorous breathing. A lumbar puncture was done and the pressure of the cerebrospinal fluid was elevated and the fluid was bloody. Shortly before death

Table VII

"IMMEDIATE" DEATHS FOLLOWING INJECTION OF A CONTRAST MEDIUM FOR A STUDY OF THE URINARY TRACT

Case No.	Sex	Age in yr.	Clinical Diagnosis	Clinical Findings	Contrast Medium	History of Allergy	Sensitivity Test	Time of reaction and Character	Time of Death	Autopsy	Designated Cause of Death
1	F	24	Ureteral calculus	Vague abdominal	Diodrast 35%	Food?	Intraoral and I.V. —neg.	After injection of 5 cc., urgency of urination; dyspnea, cyanosis, convulsion	20 min.	Not done	Contrast medium
2	M	65	Urinary obstruction, prostatism	Previous carcinoma, rectum	Diodrast 35%	Negative	Conjunctival and I.V.—neg.	Immediate dyspnea, restlessness, shock	15 min.	"Marked dilatation of both lungs"	Contrast medium
3	M	56	Hypertensive cardiovascular disease with failure	Asthma; weight loss; nocturia, cardiac enlargement	Diodrast 35%	Asthma 15–20 yr.	Conjunctival—neg.	2 min. after injection, sudden dyspnea	3–4 min.	Primary bronchial asthma. Patch pulmonary atelectasis; myocardial hyperatrophy; arteriolonephrosclerosis	Contrast medium
4	F	55		Pain, right flank	Neo-iopax 50%	Negative	Not done	45 sec. after injection, patient turned cyanotic, stopped breathing, pulseless, had cardiac arrest; cardiac massage done	36 hr. after cardiac arrest and thoracotomy	Cerebral anoxia; lower nephron nephrosis; fatty infiltration of liver; hemorrhagic pulmonary edema; acute cardiac dilatation	Contrast medium
5	M	64	Hepatitis cardiomegaly; renal calcification	Jaundice; hepatomegaly; renal calcification; gastric resection 4 mo. before for bleeding ulcer	Diodrast 35%	No record	Not done	A few minutes after injection, pressure feeling in chest, dyspnea	2½ hr.	Hepatitis; arteriolonephrosclerosis; renal cyst; arteriosclerosis; pulmonary edema	Contrast medium
6	M	70	Prostatism	Frequency; nocturia	Diodrast 35%	No record	Skin test—neg.	10 min. after injection, sudden dyspnea, cyanosis, pulseless, inaudible heart sounds	"A few min."	Not done	Contrast medium
7	F	38	Urethritis	Dysuria; hematuria	Diodrast 35%	Negative	Not done	After 18 cc., aphasia—followed by improvement, then convulsive seizure, coma	Less than 24 hr.	Cerebral edema; acute hyperemia of lungs and abdominal viscera	Contrast medium
8	M	55	Ureteral calculi; nephrosis; gastrojejunostomy with marginal ulcer	Repeated GI bleeding; severe headaches; disorientation	Diodrast 35%	No record	Not done	Immediate dyspnea followed by clonic convulsions	"A few min."	Pulmonary edema and emphysema; nephrosclerosis; internal hydrocephalus and arachnoiditis	Contrast medium
9	M	48		Lumbar pain	Urokon sodium 30%	Negative	Conjunctival—neg.	After completion of study, fainted several times. Convulsion	2 hr.	Not done	Contrast medium
10	F	50			Diodrast 35%	Negative	Conjunctival skin and I.V.—neg.	Immediate choking feeling, thready pulse, convulsive seizure	2–3 min.	Not done	Contrast medium
11	F	45	CNS lesion?		Diodrast 35%	Negative	Skin—neg.	After 2 cc. diodrast, severe convulsions, coma, and repeated convulsions during next 24 hr.	24 hr.	Not done	Contrast medium
12	F	28	Hypertension		Diodrast 35%	Negative	I.V. test—neg.	After 7 cc. had been injected, blood pressure dropped, cy-	2 hr.	Nothing significant	Contrast medium

Table VII—*Continued*

TABLE VII—*Continued*

Case No.	Sex	Age in yr.	Clinical Diagnosis	Clinical Findings	Contrast Medium	History of Allergy	Sensitivity Test	Time of Reaction and Character	Time of Death	Autopsy	Designated Cause of Death
13	F	42	Pyelonephritis		Diodrast 35%	Negative	Not done	After injection of 2 cc. choking, dyspnea	3 min.	Not done	Contrast medium
14	M	62	Hypertension; prostatism; previous coronary thrombosis		Diodrast 35%	Negative	I.V. test—neg.	3 min. after injection, "shock"	8 min.	No recent cerebrocardiovascular accident	Contrast medium
15	M	45	Hypertension	Previous symptoms of cerebral anoxia	Diodrast 35%	No record	No record	Within 2–3 min. after injection, generalized convulsion	10 min.	No record	Contrast medium
16	F	2½	Primary pulmonary vascular sclerosis; previous symptoms of unconsciousness; opisthotonos, cyanosis	Abdominal mass	Neo-iopax 75%	Negative	I.V.—neg.	2 min. after completion of injection, patient stiffened and became cyanotic; convulsions	15 min.	Pulmonary vascular sclerosis; chronic passive liver congestion, arteriosclerosis	Contrast medium
17	M	39	Possible ureteral calculus	Left abdominal pain	Diodrast 35%	Negative	Intraoral—neg.	3 min. after injection, patient had difficulty breathing, became cyanotic; air hunger; later, convulsions	A few min.	Not done	Contrast medium
18	F	35			Neo-iopax and Diodrast	No record	No record	No details; reaspirations ceased. Heart stopped beating	45 min.	Not done	Contrast medium
19	F	59	Rheumatic heart disease	Pain in L.U.Q., nausea, vomiting, constipation, tenesmus, 20 lb. weight loss, cardiac enlargement, auricular fibrillation	Diodrast 35%	Urticaria since age 6	Not done	Difficulty breathing. Blood pressure and pulse unobtaintainable; cyanosis	6 hr.	Mitral stenosis, auricular thrombosis; multiple emboli with infarction in spleen, kidneys, small intestine; embolic occlusion of aorta	Contrast medium plus patient's disease
20	M	51	Hypertension	Apprehensive, Hematuria, BUN 56	Diodrast 35%	Negative	Conjunctival—neg.	After 10 cc., nausea, retching, abdominal pain, convulsive seizures, depressed respirations	5 min.	Cardiac hypertrophy; coronary occlusion; severe nephritis	Contrast medium plus patient's disease
21	M	52		Sudden pain in back and lower quadrants; convulsion	Neo-iopex 75%	Negative	I.V.—neg.	Immediate convulsion; unconsciousness	30 min.	Ruptured dissecting aneurysm aorta; hemopericardium	Contrast medium plus patient's disease
22	M	53	Calculus, right	Severe pain in region of kidneys	Diodrast 35%	Negative	No record	Pale and lethargic at time of examination—20 min. after injection, increasing dyspnea and choking	About 30 min.	Not done	Contrast medium plus patient's disease
23	M	57	Nephrolithiasis, gout		Diodrast 35%	None	No record	Immediate, "anaphylactic"	30 min.	Anaphylaxis; nephrolithiasis; gout	Contrast medium
24	M	50+			Diodrast 35%	None	Conjunctival	Immediate	20 min.	None	Contrast medium
25	M	50+			Diodrast 35%	None	Conjunctival	Immediate	20 min.	None	Contrast medium

she had epistaxis. Death occurred less than twenty-four hours after the injection of the medium. The postmortem examination showed cerebral edema, acute hyperemia of the lungs and abdominal viscera, fresh blood in the mouth, nares and stomach.

Comment. The cause of death was attributed to cerebral edema. The patient was a young woman in apparent good health except for symptoms of urethritis. The diodrast was thought to be the cause of death.

Case 8. Reported through the courtesy of Dr. J. J.

A white man, aged fifty-five, was admitted to the hospital for study of the genitourinary tract. The past medical history included a subtotal gastric resection, cholecystectomy, orchiectomy, fracture of the left femur and poliomyelitis. For five years prior to admission he had had repeated attacks of gastrointestinal bleeding. He complained of severe occipital headaches and episodes of disorientation.

The record did not mention whether the patient had allergic diseases. A sensitivity test was not done. Twenty cubic centimeters of 35 per cent diodrast were injected in about two minutes. Almost immediately after completion of the injection, the patient sat up on the table and appeared to have pulmonary edema. He then had several clonic convulsions. An anesthetist inserted an air-way and administered oxygen. An intracardiac injection of adrenalin was made. He died within a few minutes.

Comment. The pathologist stated: "The cause of death is obscure. The pathologic findings were as numerous as were his various complaints and clinical findings. He died shortly after an intravenous injection of diodrast which had resulted in clonic convulsions. There was adhesive arachnoiditis which had produced an internal hydrocephalus with resulting compression of the tissues of the cerebral hemispheres and brainstem. There was also generalized arteriosclerosis and arteriolosclerosis, a marginal ulcer at the gastroenterostomy, generalized dermatitis of unknown origin and liver disease. Additional findings included hydronephrosis and a calculus in the right ureter." Death was attributed to vasomotor collapse due to sensitivity to diodrast.

Case 9. Reported through the courtesy of Dr. B. R. W.

A white man, aged forty-eight, was referred for intravenous urography because of lumbar pain. There was no history of allergy and a conjunctival test was negative. Twenty cubic centimeters of urokon sodium 30 per cent were injected over a five minute period. The studies were completed satisfactorily, but the patient fainted when arising from the table. He was revived with aromatic spirits of ammonia but again fainted several times and adrenalin was administered. Because of the syncopal attacks, he was removed to a hospital about one hour after the administration of urokon sodium. He died in the hospital during a convulsion approximately two hours after the injection. An autopsy was not done.

The urograms showed progressive increase in the concentration of contrast medium within the renal parenchyma throughout a thirty minute period but none in the pelves or calyces.

Comment. For some reason, the medium did not pass from the renal parenchyma into the collecting systems. Death was attributed to urokon sodium.

Case 10. Reported through the courtesy of Drs. G. B. S. and E. F.

A white woman, aged fifty, was referred for intravenous urography. There was no history of allergy, and skin and conjunctival tests were negative. The first cubic centimeter was injected and, after a two to three minute wait, the remainder of the solution was injected. The entire 20 cc. of 35 per cent diodrast was given in about two or three minutes. The patient immediately complained of choking, the pulse became thready and she had a convulsive seizure. Her respirations stopped within two to three minutes and the pulse was not palpable. Intracardiac adrenalin, intravenous adrenalin and caffeine were of no avail. An autopsy was not done.

Comment. We have no information concerning this patient's clinical status but the description of symptoms following the injection of diodrast indicates that the patient suffered a fatal reaction to the medium.

Case 11. Reported through the courtesy of Dr. O. N.

A white woman, aged forty-five, was referred for intravenous urography. (Full details of the history are not available but it is believed that the patient had a disease of the central nervous system.) There was no history of allergy and a skin test was negative. After injection of 1 or 2 cc. of diodrast, the patient had a severe convulsion and the injection was discontinued. The convulsion lasted about ten minutes. The patient remained in coma during the next twenty-four hours and had repeated convulsions during that time. She died about twenty-four hours following injection of diodrast. An autopsy was not done.

Comment. It was felt that other factors than the opaque medium might have been responsible for the patient's death.

Case 12. A woman, aged twenty-eight, was referred for urography because of hypertension of one year's duration (since pregnancy). She had no allergic history. An intravenous test was negative. After 7 cc. of 35 per cent diodrast had been injected, the patient went into a shock-like state—the blood pressure dropped, she became cyanotic and unconscious. Adrenalin and oxygen were of no avail. The patient died about two hours after the injection. The autopsy revealed no significant findings.

Comment. Death was thought to be due to injection of diodrast.

Case 13. Reported through the courtesy of Dr. A. J. S. and Dr. A. J. S., Jr.

A white woman, aged forty-two, was referred for intravenous urography because pyelonephritis was suspected. The patient had no personal history of allergy but had a family history of asthma. A sensitivity test was not done. The intravenous injection of 35 per cent diodrast was begun and, after 2 cc. had been injected, the patient complained of choking and inability to get her breath. With one gasp for air, she died. Stimulants were of no avail. Death occurred about three minutes after the injection. An autopsy was not done.

Comment. It seems very likely that death was caused by the diodrast.

Case 14. Reported through the courtesy of Dr. J. H. B.

A white man, aged sixty-two, was referred for intravenous urography because of hypertension and prostatic disease. The patient had had coronary thrombosis five years previously. There was no history of allergy. The intravenous injection of 35 per cent diodrast was begun and 1 cc. was injected very slowly with a short period of observation of the pulse and general condition before injection of the entire dose. About three minutes after completion of the injection, the patient went into a shock-like state. Emergency treatment, consisting of oxygen administration, tracheal intubation and adrenalin were futile and the patient died about eight minutes following the injection. An autopsy showed no evidence of a recent cerebral cardiovascular accident.

Comment. Dr. B. stated that, in his opinion, the clinical picture was rather typical of a severe anaphylactoid-type reaction due to diodrast sensitivity.

Case 15. Reported through the courtesy of Dr. R. J. R.

A white man, aged forty-five, had a history of severe hypertension and previous symptoms of cerebral anoxia. No further details are available.

Twenty cubic centimeters of 35 per cent diodrast were given intravenously over a period of two to three minutes. Within two to three minutes after the injection, the patient had a generalized convulsion and in spite of supportive measures died within ten minutes after the onset of the convulsion.

Comment. This patient apparently was in poor condition and death cannot be attributed solely to the medium. It might have acted as a trigger mechanism.

Case 16. Reported through the courtesy of Dr. J. A. C.

A white girl, aged two and a half years, was admitted with the chief complaint of an abdominal mass. At the age of twenty-one months, the child suffered an episode characterized by unconsciousness, upward deviation of the eyes, opisthotonos and cyanosis. The child was unconscious for a short time. There were no twitchings. During the subsequent seven months she had 20 to 30 such episodes. These ceased spontaneously. The attacks were usually preceded by abdominal pain. Three to four months before admission puffiness of the face had been noted. Two months before admission

the child had had an episode of what was said to be pneumonia and at that time the right eye was noted to be red. The local physician explained the redness of the eye on the basis of a broken blood vessel. A week prior to admission, the patient was found to have a large mass in the abdomen, primarily in the right upper quadrant but with extension across the midline.

There was no history of allergy. When no reaction followed the injection of 1 cc. of 75 per cent neo-iopax, the intravenous administration was continued. After 3 cc. of the medium had been injected intravenously, the needle slipped out of the vein. About five minutes after the injection, a second venous punture was made and 12 cc. of neo-iopax injected. Two minutes after completion of this injection, the patient stiffened and became cyanotic. Supprotive measures, including adrenalin and oxygen, improved her color somewhat, but the convulsions persisted and respirations became jerky. Respirations then stopped and the cardiac sounds became inaudible. About fifteen minutes had elapsed from the time of the first injection of neo-iopax.

The autopsy revealed the following: (1) primary pulmonary vascular sclerosis, advanced; (2) cor pulmonale (heart weight 190 gm.; average normal, 59 gm.); (3) chronic passive congestion of the liver (500 gm., normal 400 gm.); (4) arteriolosclerosis and arteriosclerosis, generalized, minimal; (5) passive congestion of the choroid and ciliary body of the right eye; (6) thrombosis of the small veins of the choroid of the right eye.

Comment. Dr. C. stated: "Since these cases are usually uniformly fatal in early life, it is probable that a variety of agents given intravenously may act as a trigger mechanism to produce a fatal episode."

Case 17. A man, aged thirty-nine, in good physical condition was referred for intravenous urography because of pain in the left abdomen possibly due to ureteral calculus. There was no history of allergy and an intraoral test was negative. Twenty cubic centimeters of 35 per cent diodrast were injected intravenously, moderately slowly. About three minutes after completion of the injection, the patient had difficulty in breathing, became cyanotic and showed increase in general activity in an attempt to gain air. The injection of adrenalin intracutaneously gave temporary relief; that is, breathing became easier and there was less cyanosis. However, this was shortly followed by a return of the symptoms to an increased degree accompanied by very active convulsive-like activity. Intramuscular coramine, oxygen under pressure and adrenalin were to no avail. An attempt at intubation was unsuccessful.

Comment. Death was undoubtedly due to the diodrast.

Case 18. Reported through the courtesy of Dr. R. S. G.

A white woman, aged thirty-five, died forty-five minutes after the injection of opaque medium. Two cubic centimters of neo-iopax (concentration not stated) were injected, but the administration was discontinued because of extravasation. Because of poor veins, diodrast (concentration not stated) was substituted and injected slowly in a very small vein; 20 cc. were given. There was no sense of discomfort. The patient conversed with the physician and technician up to moment before death. The technician was adjusting the film for the final exposure when the patient stopped breathing and the heart stopped. Artificial respiration, oxygen and adrenalin failed to revive her.

Comment. We have no information as to the history of allergy or record of sensitivity tests or whether an autopsy was performed. Since the patient received two different media, it is not possible to state which of these compounds caused the reaction.

Case 19. Reported through the courtesy of Dr. J. T. F., Jr.

A white woman, aged fifty-nine, was admitted to the hospital because of pain in the left upper quadrant of the abdomen, nausea and vomiting, constipation, tenesmus and 20 pounds weight loss in the seven months prior to admission. She had had rheumatic fever twenty years before and had been subject to hives since the age of six. The physical examination showed cardiac enlargement and tenderness in both upper quadrants of the abdomen.

A sensitivity test was not done. Twenty cubic centimeters of 35 per cent diodrast were given intravenously and after the injection the patient began to breathe with difficulty. The pulse and blood pressure were unobtainable

and adrenalin, coramine and 50 cc. of 50 per cent glucose were given intravenously. She seemed to improve following artificial respiration. Cyanosis developed, cleared, and then returned. Although the heart sounds were always good, she improved only slightly so far as her circulatory status was concerned and she died about six hours after the administration of the medium.

The postmortem examination showed an old rheumatic mitral stenosis with auricular thombosis. There were multiple emboli with infarctions in the spleen, kidneys and small intestine and there was also embolic occlusion of the abdominal aorta.

Comment. Those who saw her thought that death was not due to diodrast. Certainly this patient had an extensive disease and death was imminent. The medium may have acted as a trigger mechanism.

Case 20. Reported through the courtesy of Dr. R. S. B.

A white man, aged fifty-one, with hypertension was referred to the Department of Radiology for intravenous urography. During the hospital stay, the patient was very apprehensive and had hematuria. The blood urea nitrogen was 56 mg. per cent. There was no history of allergy and a conjunctival test was negative. The intravenous injection of 35 per cent diodrast was begun and the first 2 cc. were injected over a period of two minutes. An additional 8 cc. were then injected slowly, whereupon the patient complained of nausea, began to retch but did not vomit. Within a few seconds he complained of pain in the abdomen and developed jerky movements. He became moderately pale and developed mild clonic convulsive seizures involving the entire body, but more marked on the left side. Breathing became depressed and in spite of the administration of adrenalin and oxygen the patient died. Artificial respiration was also employed. Death occurred about five minutes after the injection was discontinued.

The autopsy revealed the following significant findings: Heart—hypertrophy; severe coronary sclerosis with occlusion of the anterior descending branch, also occlusion of the circumflex branch, left coronary at approximately its middle third. No thrombus was found. The occlusion seemed to be caused for the most part by severe sclerosis. Kidneys—severe chronic nephritis, probably vascular in origin with some chronic pyelonephritis.

Comment. Dr. B. stated: "I do not believe that this can be considered a true diodrast so-called allergic death. The patient was a poor risk and death was impending, but again, the contrast medium may have been the immediate cause of death."

Case 21. Reported through the courtesy of Dr. J. F. H.,

A male Filipino, aged fifty-two, had complained of sudden lancinating pain in the back and lower quadrants before entry to the hospital. He had also had a chill, nausea and vomiting. At that time, the blood pressure was 170/100. The urine was negative except for a trace of albumin. Just before admission, he had had a convulsive seizure but did not become unconscious. At the time of admission, the blood pressure was 90/70. The urinalysis showed a few hyaline casts, 50 to 75 red blood cells per high power field. The Kahn and Wassermann tests were negative. The pulse varied between 70 and 115, and respirations were about 20. During the two days on record, the temperature rose as high as 101.5° rectally.

The patient was sent to the Department of Radiology where 20 cc. of 75 per cent neoiopax were injected intravenously during a period of five minutes. Almost immediately after the injection was completed, the patient had a sudden convulsive seizure, followed by unconsciousness. All attempts at revival, including adrenalin, coramine, oxygen and artificial respiration were unsuccessful. The patient died about thirty minutes later.

The following remarks are excerpts from the coroner's autopsy: The pericardial sac was distended with a large amount of partly clotted blood. It was found that this originated in a ruptured dissecting aneurysm of the aorta. The dissection originated in the arch of the aorta and dissected in both directions to an aortic ring and out along the coronary artery and downward into the abdominal aorta and into the bifurcation of the aorta. The aorta showed areas of necrosis of the atherosclerotic plaques and it was through one of these that the dissecting aneurysm originated. There was no evidence of other disease of the aorta, except atherosclerosis. The heart showed moderate enlargement due in the main to left ventricular

TABLE VIII

SUMMARY OF DEATHS IN THE "IMMEDIATE" GROUP AND THE MEDIA EMPLOYED

Media Employed	Patients
Diodrast 35%	20
Neo-iopax (1 case 50%; 2 cases 75%)	3
Urokon sodium 30%	1
Diodrast and neo-iopax	1
TOTAL	25

hypertrophy. The coronary vessels showed moderate atherosclerotic change but the lumens appeared adequate throughout. There was considerable hemorrhage along the course of each coronary artery. The myocardium was intact and showed no localized lesions except for a mottled area in the interventricular septum. Both lungs showed diminished aeration, and section through them revealed a moderate acute pulmonary edema and some atelectasis. The liver, spleen, pancreas and adrenals appeared normal. The kidneys were essentially normal. Diagnosis: Hemopericardium from a ruptured dissecting aneurysm of the aorta due to aortic atherosclerosis. Arteriosclerotic cardiovascular disease.

Comment. Those who saw the patient believed that the intravenous injection was the immediate cause of death although death was impending.

CASE 22. Reported through the courtesy of Dr. D. D. B.

A white man, aged fifty-three, was admitted to the hospital complaining of "severe pain in the kidneys." Urinalysis showed 4 plus albumin. At the time of urography, the patient was said to be pale and lethargic. A preliminary roentgenogram showed a large staghorn calculus in the right kidney. There was no history of allergy. Ten and twenty minute roentgenograms were made after the diodrast was injected (30 cc. of 35 per cent diodrast in one minute), and there was no excretion by either kidney. Shortly after the twenty minute roentgenogram, the patient complained of increasing dyspnea and died shortly thereafter. Emergency measures were futile.

The patient had had 17 admissions to another hospital during a seven year period because of urologic complaints. He had had bilateral urinary calculi and several operations for removal of stones. The portmortem blood examination revealed a nonprotein nitrogen of 167 and a creatinine of 5.1. Cause of death was given as "coronary thrombosis."

Comment. Dr. B. stated: "From the above, you can see that it is difficult to definitely incriminate diodrast, although it certainly could have been a contributory cause of death. It may have been a misdiagnosis and the patient may have had a myocardial infarct when he came to the x-ray department."

CASE 23. Reported through the courtesy of Dr. H. M. W.

A fifty-seven year old man, with clinical findings of gout and nephrolithiasis, suffered a fatal, anaphylactic reaction and died ten minutes after the intravenous injection of 20 cc. of 35 per cent diodrast. Artificial respiration and oxygen inhalation were futile.

Comment. Death was directly attributable to the contrast medium.

CASES 24 and 25. Deaths reported through the courtesy of Drs. M. G. W. and L. N. Complete details not available.

Both patients were men over fifty years of age and both received intravenous injections of 20 cc. of diodrast 35 per cent. In both instances, death occurred about twenty minutes following administration of the medium. There was no history of allergy in either case and both conjunctival and skin tests were negative. Both patients had severe renal damage. Autopsies were not performed.

Comment. Death occurred immediately in both cases and can be attributed to the contrast medium.

Additional Comments. Of the 25 deaths in the "immediate" group, 20 received injections of diodrast, 3 neo-iopax, 1 urokon sodium, and 1 received diodrast and neo-iopax (Table VIII).

Negative sensitivity tests were present in 15 of the 22 "immediate" deaths (Table IX).

One patient who died (Case 18) received neo-iopax and diodrast. We cannot predict which medium was responsible for the death.

TABLE IX

SENSITIVITY TESTS PERFORMED OR NOT PERFORMED IN THE "IMMEDIATE" DEATHS

Test performed		15 patients
Intravenous	4	
Conjunctival	3	
Skin	2	
Intraoral	1	
Conjunctival, skin and intravenous	1	
Conjunctival and intravenous	1	
Intraoral and intravenous	1	
Conjunctival and skin	2	
Test not performed		6 patients
No record		4 patients

In Table x, the patients are listed in whom the reactions occurred before the injections of the contrast media were completed. Two of the patients had reactions following the injection of only 2 cc. of the medium. This observation is of interest because many radiologists use the intravenous test; that is, they inject a small amount of medium (usually about 1 cc.), wait for a few minutes and proceed with the injection if no reaction becomes manifest.

We have attempted to classify the reported reactions in Table xi, and the symptomatology in Table xii.

The distribution of reactions, as far as age and sex are concerned, is shown in Table xiii.

Some deaths reported to us in this survey have not been included for various reasons: 1 death occurred during retrograde pyelography; 2 deaths could not be verified officially; 2 deaths occurred in bronchography; and several deaths occurred during angiography. *There were 2 patients who died in departments of radiology while being prepared for the diagnostic procedure of urography, but who had not received any contrast medium.*

TABLE X

PATIENTS IN WHOM THE REACTIONS TOOK PLACE BEFORE THE INJECTION OF THE CONTRAST MEDIA WAS COMPLETED

Case Number	Amount of Diodrast Administered When the Reaction Occurred
1	5 cc.
7	18 cc.
11	2 cc.
12	7 cc.
13	2 cc.
20	10 cc.

TABLE XI

TYPES OF REACTIONS OCCURRING IN THE 25 "IMMEDIATE" DEATHS

Types of Reaction	Number of Patients
Nervous system	6
Respiratory	10
Cardiac	2
Shock	2
Indeterminate	4
Anaphylaxis	1
TOTAL	25

TABLE XII

SYMPTOMATOLOGY IN THE 25 "IMMEDIATE" DEATHS

Symptoms	Number of Patients*
Dyspnea	11
Cyanosis	7
Pressure in chest	1
Shock	2
Convulsions	10

* Some patients had more than one symptom.

TABLE XIII

AGE AND SEX IN "IMMEDIATE" DEATH GROUP

		Years
AGE	Youngest	2½
	Oldest	70
SEX	Male	15
	Female	10

DELAYED DEATHS

Some of these patients are included because death occurred following intravenous

urography in spite of the fact that we were unable to be certain as to the relationship of the contrast medium to the patient's death.

Case 26. Reported through the courtesy of Dr. L. E. W.

A white man, aged seventy, was referred for intravenous urography. The radiologist was unaware of the possibility of glomerulonephritis. There was no history of allergy and a preliminary skin test was negative. Twenty cubic centimeters of 35 per cent diodrast were given intravenously in a period of about five minutes. The patient died of uremia the following day. No autopsy was performed. It was thought that death was precipitated by the contrast medium.

Comment. Since the clinical findings are not available and there was no autopsy, it is difficult to say what role the injection of diodrast played in this death.

Case 27. Reported through the courtesy of Dr. B. F. Full details not available.

A man, age unknown, was referred for intravenous urography because of prostatism. The blood urea nitrogen was 60 mg. per cent. There was no reaction following injection of 30 cc. of 35 per cent diodrast, but the blood urea nitrogen began to climb the following day and its value reached the neighborhood of 100 mg. per cent. The patient became anuric and died forty-eight hours after the urogram.

Comment. It was believed that the patient, who was already seriously ill, might have died even had the urogram not been made.

Case 28. Reported through the courtesy of Dr. B. F.

A man, whose blood urea nitrogen was elevated at the time of the intravenous urogram (30 cc. of 35 per cent diodrast) and which later climbed to well over 100 mg. per cent, died two to three days after the urogram.

Comment. Dr. F. feels that this patient and the other patient reported by him (Case 27) might have died in spite of the urogram, and doubts that these cases should be included.

INDETERMINATE DEATHS

Case 29. Death reported through the courtesy of Dr. L. J. F. Full details not available.

An adult man died following injection of 35 per cent diodrast.

Case 30. Reported through the courtesy of Dr. J. H. W. Full details not available.

A patient died suddenly following administration of 35 per cent diodrast.

Case 31. Reported through the courtesy of Dr. R. H. M.

A child (girl) died following intravenous injection of diodrast. No further details available.

DEATH AFTER PYELOGRAPHY

Case Report of death during the course of retrograde pyelography. Reported through the courtesy of Dr. M. S.

A white woman, aged fifty, was admitted to the hospital for the fifth time. The four previous admissions were concerned with her diabetes, hypertensive heart disease, coronary thrombosis, and infections of both feet. Because of a suspected right renal calculus, two excretory and two retrograde pyelograms had been performed, all without reaction. Diodrast was the medium used. Excretory urograms were said to show no evidence of the contrast medium in the right urinary tract, even though the retrograde studies had shown no abnormalities.

In December, 1947, an amputation of the right leg below the knee was performed for arteriosclerotic gangrene of the right foot. The patient was last admitted on January 29, 1948, because of rectal bleeding. A barium enema was negative. The patient also complained of pain in the right upper quadrant and cholecystography showed an abnormal function of the gallbladder. Another excretory urogram was performed, with unsatisfactory findings due to gas in the bowel.

On March 11, 1948, with a temperature of 105° F., the patient was cystoscoped in the operating room and sent to the Department of Radiology with ureteral catheters extending into both renal pelves. Upon injecting the right catheter, and apparently a considerable amount of contrast medium was used, inasmuch as there was reflux down the entire ureter into the bladder, the patient gasped and died. A review of the pyelogram showed a Grade 1 pelvocaliectasis with a suggestion of slight irregular corti-

cal atrophy. No pyelorenal backflow was noted.

An autopsy revealed the following: Coronary arteriosclerosis with an old calcified occlusion of the left anterior descending branch; marked myocardial fibrosis, with a healed infarct at the apex; hypertrophy and dilatation of the heart; atherosclerosis of the aorta and cerebral arteriosclerosis; bronchopneumonia; arteriolonephrosclerosis.

Comment. It is doubtful that the opaque medium can be incriminated in this case. This patient had already had examinations employing diodrast and she had sustained no untoward reactions. She was in extremely poor clinical condition.

FATAL CASES OBTAINED FROM THE LITERATURE

A review of the literature of the United States shows that only 2 fatal reactions in urographic studies attributable to the injection of contrast media have been reported since our original publication (Table XIV).

Summary of Case Report. In 1948, Simon[27] reported the case of a white woman, aged twenty-three, who had had hematuria following an automobile accident. There was no history of allergy. Three minutes after injection of 25 cc. of 35 per cent diodrast, the patient began to vomit, felt "numb all over," and became cyanotic. The pulse became thready and the respirations irregular. She died twenty minutes following the injection. An autopsy revealed congestion and edema of all of the viscera, scattered petechial hemorrhages over the surfaces of the lungs and many petechial hemorrhages in the brain.

Summary of Case Report. In 1951, Gulotta and Leavenbrook[16] recorded the case of a woman, aged twenty-two, who had been referred for urography because of pain in the right flank. Within a few minutes after injection of 20 cc. of 35 per cent diodrast, she had generalized convulsions and became unconscious. She had repeated convulsions which were controlled with sodium amytal. In spite of various supportive measures, she developed papilledema, and the lungs became filled with coarse rales. She died twenty-eight hours later. Autopsy showed the following significant findings: pulmonary congestion and edema, and patchy bronchopneumonia. Sections from the left frontal lobe showed obliteration of the normal architecture by recent blood extravasation; numerous polymorphonuclear leukocytes were present in the embedded vessels, in their walls, in the perivascular spaces, and in the parenchyma. The overlying meninges presented marked vascular congestion and considerable polymorphonuclear cell infiltration. Sections from the pons and medulla showed similar but less extensive changes.

PRECAUTIONARY MEASURES PRIOR TO INTRAVENOUS UROGRAPHY BASED ON SURVEY

The precautions recommended by radiologists to prevent reactions in intravenous urography are shown in Table XV. Many radiologists made an effort to secure a history regarding allergy, either in the patient or in his family, reactions to previous iodine studies, and to iodine sensitivity. It was noted, however, that in many instances, such a positive history was not considered a contraindication, but was used rather as an indication for the need of

Table XIV

SUMMARY OF FATAL CASES OBTAINED FROM THE LITERATURE OF THE UNITED STATES SINCE OUR PREVIOUS SURVEY

Author	Year	Number of Cases	Medium	Remarks
Simon[27]	1948	1	Diodrast	Immediate reaction; death 20 minutes after injection
Gulotta and Leavenbrook[16]	1951	1	Diodrast	Reaction within a few minutes; death in 28 hours

TABLE XV

PRECAUTIONARY MEASURES PRIOR TO INTRAVENOUS UROGRAPHY BASED ON SURVEY AMERICAN COLLEGE OF RADIOLOGY

	Number of Questionnaires		Percentage of Questionnaires
Questionnaires in survey usable in whole or in part		1,272	100.0
Questionnaires reporting			
History taken regarding allergies, previous iodine studies, iodine sensitivity		737	57.9
Preliminary local sensitivity tests			
Conjunctival test	246		19.4
Intradermal test	235		18.5
Intraoral test	54		4.2
Combination or type of test not specified	143		11.2
TOTAL		678	53.3
Only when allergic history obtained	45		3.5
TOTAL, WITH OR WITHOUT ALLERGIC HISTORY		723	56.8
Intravenous test			
Routinely	509		40.0
With allergic history	21		1.7
TOTAL INTRAVENOUS TESTS		530	41.7
Preliminary medication			
Antihistamines	94		7.4
Barbiturates	10		0.8
Epinephrine	13		1.0
TOTAL PRELIMINARY MEDICATION		117	9.2
Slow injection contrast media		414	32.5
Emergency medication			
Emergency tray (epinephrine, other drugs, etc.)	501		39.4
Epinephrine available	205		16.1
TOTAL EMERGENCY MEDICATION		706	55.5
Oxygen at hand (at or near site of examination)		80	6.3

extra caution in performing the diagnostic urographic test.

Some type of preliminary local sensitivity testing was reported in 56.8 per cent of the 1,272 questionnaires we analyzed. In 3.5 per cent of the questionnaires studied, preliminary testing was indicated as being done only when there was an allergic history. The conjunctival test was used by 19.4 per cent of the radiologists; the intradermal test by 18.5 per cent; the oral test by 4.2 per cent, and 11.2 per cent used a combination of these tests or did not specify type of test used. Many volunteered the information that these tests were done purely for medicolegal reasons.

Intravenous tests were done routinely by 40 per cent of the radiologists, and in the presence of an allergic history by an additional 1.7 per cent. Many of those using the intravenous test did so in addition to the local sensitivity tests.

Two radiologists listed intramuscular tests among their precautions. This test was advocated by them with the feeling that it was nearly as reliable as the intravenous test, and much more reliable than a local sensitivity test. They considered it relatively easy to perform, and perhaps safer than the intravenous test.

Slightly over 9 per cent gave some type of preliminary medication, either routinely or in the presence of allergy, a positive sensitivity test, or marked apprehension. Antihistamines were by far the most popular type of premedication, being listed in 7.4 per cent of the questionnaires, with barbiturates and epinephrine each being

used to a lesser extent. Epinephrine often was included in the contrast media.

Slow injection was recommended by many. In other instances, however, only the first portion of the medium was injected slowly.

Several radiologists reported that the incidence of reactions in their practice decreased sharply after instituting procedures which assured meticulous cleanliness of the syringes and needles employed in intravenous urography.

Over one-half of the doctors indicated that they were prepared for some type of emergency medication.

CONTRAINDICATIONS TO THE USE OF CONTRAST MEDIA

The questionnaires were analyzed for the contraindications to intravenous urography (Table XVI). In many instances there were qualifying statements which could not be included.

The most frequent contraindication was uremia, which was listed in 72.1 per cent of the 1,272 questionnaires which were analyzed. Several radiologists stated that they felt that uremia was a contraindication only because the study would be unsatisfactory.

The next most frequent contraindication was a known sensitivity to iodine, or a history of reaction to a previous urogram. Among the substances about which patients were specifically questioned were seafoods and gallbladder media. In several instances, the radiologists stated they had done urograms without any difficulty in spite of a previous history of severe reaction.

Approximately 31 per cent stated that an allergic history or known sensitivity to noniodine-containing drugs when given by parenteral route was a contraindication. The degree of allergy, particularly the range of material to which the patient was sensitive, was taken into account to different degrees by almost every physician. Some radiologists considered a severe allergic history a contraindication in the presence of a positive sensitivity test. Others stated that an active allergy at the time of examination, particularly bronchial asthma, was a contraindication to urography.

A few listed severe cardiac diseases, particularly recent coronary occlusion, or actual or threatened cardiac decompensation as contraindications.

Severe liver diseases, debility, fever, systemic toxicity, severe hypertension, marked apprehension, shock, active tuberculosis, and hyperthyroidism were mentioned as contraindications.

We have recommended intravenous urography and have done the procedure in many of the conditions and diseases included in the list of contraindications shown in Table XVI. We have not listed any particular condition as an absolute contraindication. Our opinion as to whether the procedure is indicated is based on

TABLE XVI

CONTRAINDICATIONS TO INTRAVENOUS UROGRAPHY AS REPORTED BY RADIOLOGISTS

	Number of Questionnaires	Percentage of Questionnaires
Questionnaires in survey usable in whole or in part	1,272	100.0
Uremia	917	72.1
Acute renal disease	76	6.0
Known iodine sensitivity or history of previous reaction to intravenous urogram	876	68.9
Severe allergic history ("broad spectrum allergy") or sensitivity to other parenteral medications	400	31.4
Severe allergic history with positive sensitivity test	20	1.6
Active allergy	29	2.3
Severe cardiac disease	98	7.7
Severe liver disease	75	5.9
Severe debility	54	4.2
Fever or toxicity	18	1.4
Severe hypertension	31	2.4
Severe psychoneurosis or marked apprehension	15	1.2
Shock	14	1.1
Active tuberculosis	14	1.1
Hyperthyroidism	13	1.0

weighing the likelihood of obtaining information helpful in the treatment of the patient from the examination against the risk involved.

DISCUSSION

Reactions to Contrast Media. As a rule, reactions to urographic contrast media are mild and transient. Some of the mild symptoms include a feeling of warmth, flushing, itching, urticaria, nausea, slight substernal pressure, faintness and arm pain. Sometimes, one observes more alarming symptoms such as faintness, a shock-like state, severe dyspnea, wheezing, and even death.

The patients who died commonly revealed dyspnea and convulsions. Air hunger usually preceded the convulsions. In some, dyspnea came on slowly over a period of a few minutes; in others, it seemed to start abruptly during or immediately after the intravenous injection. As part of the respiratory difficulty, restlessness, cyanosis and pulmonary edema were recorded in a significant number of patients. Several revealed a shock-like state with hypotension, sweating, thready pulse, and ashen pallor; 1 or 2 individuals seemed to suffer considerable cardiac depression with slow feeble heart beats. Rigos, Larson and Rosenblat[25] reported "cardiac arrest" in a patient forty-five seconds after injecting 20 cc. of 50 per cent neo-iopax. In our previous report[24] it is indicated that violent allergic reactions were observed prior to death in 2 individuals. Why these deaths occurred we do not know; nor do we know with certainty the cause or causes for the milder reactions. Until more information is available concerning the manner in which these media act in man, one can only postulate concerning the pathologic physiology they invoke.

The following is a brief review of some of the observations concerned with the pharmacology of diodrast and neo-iopax following injection into rabbits, cats, and dogs: Using diodone (diodrast) and iodoxyl (neo-iopax) Weatherall[33] found that diodrast improved the output of the heart-lung preparation, whereas neo-iopax at first reduced the output and sometimes later increased it. Diodrast and neo-iopax acted in the same manner upon blood vessels. Both caused vasodilatation if injected slowly, but when injected rapidly into an artery an initial constriction often occurred. With reference to blood pressure, Weatherall found, depending upon experimental conditions, that diodrast caused either a slight reduction or a slight elevation or produced no demonstrable change. Neo-iopax likewise caused varying blood pressure responses, depending upon the experimental conditions; but neo-iopax did cause slight elevations in the blood pressure a little more often than did diodrast.

In the brain, diodrast and neo-iopax sometimes caused severe reactions in cats with immediate arrest of respiration lasting five or ten seconds accompanied by a fall in blood pressure of 20 to 80 mm. of mercury. Altered respirations were observed for a period lasting up to 10 minutes. The blood pressure rose gradually, sometimes above its normal level. The heart rate was often irregular, and convulsions were seen.

The following represents a brief review of our working knowledge about the pharmacology of diodrast, neo-iopax and urokon as they are used in man for intravenous urography:

1. They may produce mild or moderately severe subjective and objective reactions.
2. They may cause death by initiating severe dyspnea, convulsions, or cardiac distress. One medium (diodrast) seemed to elicit classical *hypersensitiveness* in 2 patients who died.
3. They may or may not affect the blood pressure, causing it to rise, or drop slightly, in about one-half of all patients.
4. Neither diodrast (35 per cent) nor neo-iopax (50 per cent) seems to change the respiratory rate when used for intravenous urography.
5. Diodrast may cause a rise in skin temperature (face and neck) of from 0.8°C. to

2.2°C. in some individuals within three minutes of the injection which may last thirty to forty-five minutes.[17]

In our discussion with Comroe,[6] he suggested that one might postulate certain physiologic responses to explain the clinical findings. The following comments represent some of Comroe's "ideas" which may serve until more facts have been gathered concerning the pharmacology of these contrast media in man:

As an explanation for the respiratory distress and convulsions observed in patients, Comroe[6] suggests that the air hunger may be due to bronchial obstruction. If the media act as direct irritants, they might cause the bronchioles to constrict.[6] Edema of the bronchial mucosa, whether due to allergy or an acute pulmonary edema might also interfere with adequate ventilation.

Pulmonary edema can occur within a minute or two in the presence of an acute left ventricular failure when the right ventricle continues to pump blood into the pulmonary circulation. Acute pulmonary edema also might occur if the pulmonary veins or venules suddenly constricted as a result of hypertonicity of the drug, its chemical composition, or its pH.

Within recent years much work has been done upon reflexes which have their origin in the pulmonary circulation or somewhere within the coronary circulation.[6] Certain chemical substances coming in contact with these sensory receptors in adequate concentration can lead to reflex bradycardia, hypotension, apnea, constriction of the pulmonary vessels and even bronchoconstriction. Using diodrast (35 per cent) and neoiopax (50 per cent) in doses of 1 cc. per kilogram, Comroe and Botelho[7] could not produce circulatory failure in cats when they injected it directly into the right auricle. The contrast medium seemed to cause respiratory depression and apnea, presumably due to a reflex (Bezold reaction) arising somewhere within the thorax which might have been transmitted through the vagus nerve. It is noteworthy that in cats no difference in reaction was observed when the iodinized urographic media were used or when their parent noniodinated formulas were injected. Comroe postulates that it is highly improbable that the Bezold reaction is the cause of death because the cerebral anoxia itself would act as a powerful stimulus to the respiratory center which should cause the patient to resume breathing.

The convulsions may be secondary to the asphyxia. One cannot gainsay the possibility that in some persons the contrast media may act as direct irritants on the cerebral circulation or even on the cerebral cortex by altering the blood-brain barrier.[5] Such an explanation seems unlikely during intravenous urography, for, even in cerebral angiography when the internal carotid artery itself is flooded, severe respiratory distress is not the rule. Respiratory distress does occur, but it usually occurs in patients who also develop convulsions and/or paralysis. Sandström[26] states that abdominal compression applied too strongly during intravenous urography may give rise to serious symptoms which may be falsely interpreted as having been caused by the toxicity of the contrast medium.

Allergy also may initiate cerebral edema. Whether the reactions are manifestations of contrast media hypersensitivity, the actual chemical substance itself, or both, remains to be decided.

In true anaphylactic shock resulting in death, there is known to occur a marked reduction in the number of circulating white blood cells, thrombocytopenia, and a decreased coagulability of the blood.[4,9,29] One of our patients who died sixteen hours following a severe reaction during the procedure of angiocardiography, seemed to develop a severe hemolytic reaction. The patient's heart was thought to have stopped beating immediately after the injection of 50 cc. of 70 per cent diodrast. His chest was opened and his heart was massaged. He made a splendid recovery, but later in the

day he began bleeding from his chest wound, the wound in his arm where his vein had been opened, and from the tracheotomy wound. The bleeding steadily increased in spite of four transfusions and appeared to be the direct cause of his death. A postmortem examination was not done; no blood studies were done before or after death.

It would seem important to study routinely the white blood cells, platelets, and blood coagulability in all patients who develop significant reactions to intravenous contrast media. Perhaps there does occur a shift in equilibrium between histamine and blood coagulants which alters the histamine-heparin-thrombin chain[15] mechanism which some have postulated. Perhaps some of these persons do develop hemoclastic reactions.

The Allergy Problem and Possible Preventive Measures. Allergy may be acquired or be artificially induced. When allergy is naturally acquired it is referred to as "atopy"; an allergy actively acquired or artificially induced is referred to as "anaphylaxis." At present, the evidence indicates that heredity plays an important role in atopy in man. The evidence also suggests that it is *atopy* which probably is responsible for some of the reactions that occur during *intravenous urography*. Acquired sensitivity, anaphylaxis, may also play a part in this problem, but the majority of evidence seems to disclaim this possibility.*

That drugs cause allergic reactions has been known for a long time.[3] The immunologic mechanisms involved in this form of allergy, however, still remain to be clarified. Although antibodies have been demonstrated to a few drugs, most people allergic to such drugs do not develop positive reactions to skin tests nor are antibodies demonstrable in their blood. To explain this anomaly some investigators have invoked Landsteiner's haptene theory[19] which suggests that a slight local injury sufficient to liberate tissue protein may be caused by the drug. This protein, they reason, then assumes the character of an auxiliary antigen which conjugates with the haptene drug to form a complete antigen.[19]

New information recently submitted by men interested in this subject seems to throw added light upon this problem. Working with animals, MacIntosh and Paton[21] and others[12] demonstrated that many nonprotein drugs release histamine from skin and muscle. If it can be proven that the same drugs act as histamine liberators in man it may explain some of the apparent sensitivity reactions observed during intravenous urography.

That there may exist an allergic basis for some of the reactions observed during urography is difficult to deny.[13] Urticaria, substernal oppression, flushing, itching, asthma, all characterize the toxic reaction pattern caused by antigenic agents and all have been described commonly during intravenous urography. It has seemed logical, therefore, that one should test for hypersensitivity to urographic media, hoping to avoid reactions by so doing.

Tuft,[30] discussing allergy problems in general practice, stated that, unless correctly used, the skin test may be the source of much confusion and misunderstanding. The positive skin reaction may mean present allergy; that is, the patient was then clinically responsive and his response to the allergen would be immediate. On the other hand, Tuft stated that the positive skin test might have no bearing whatsoever upon the current clinical problem being merely an indication of sensitivity in the past, or perhaps sensitivity yet to manifest itself in the future. Another confusing element in skin testing is Tuft's impression that slightly positive reactions in older individuals may mean just as much as marked reactions in the young. Finally, even the negative skin reaction may not exclude totally clinical hypersensitiveness.

Faced with this confusion and fortified by clinical experience one is inclined to state that preliminary testing for contrast

* Some have attributed the reactions to "colloidal shock." Urographic media are not "colloids," thus they cannot cause "colloidal shock."[13]

media hypersensitivity is of no practical value. No test has withstood the test of time and experience in intravenous urography (patch test, intradermal injection, conjunctival test, oral test).[2,20,22,28] In fact, these tests may give the physician a false sense of security.* Again and again patients with negative tests have developed severe reactions; on the contrary, patients apparently allergic have tolerated the media without the slightest untoward effect. Our present plan is to continue to use at least one of the tests as a clinical research tool, even though we believe such tests are useless as a guide in avoiding fatal reactions to the presently available urographic media. New concepts in allergy and new methods for assaying blood reactions to allergens demand continued research along these lines.[13] Until these avenues have been fully explored the study must be continued by those interested in the problem. Thus, we neither advocate nor deny the use of testing for drug hypersensitiveness. We are convinced, however, that the individual who does not test for allergy to urographic media is not neglecting the best interests of his patient. *A careful clinical history, with particular emphasis upon allergy, and studied clinical judgment still remain the sine qua non in this field of medical practice!*

There is an increasing tendency to combine antihistamine drugs with urographic media. Olsson[23] and more recently Inman[17] have advocated their combined use in the same syringe, feeling it has reduced untoward reactions in a most convincing manner. Olsson's[23] incidence of reactions following 20 mg. of benadryl, dropped from an average of 25 per cent to 6 per cent; Inman's[17] results using 100 mg. pyribenzamine or 50 mg. trimeton were less striking, dropping 35 per cent. Vastine[32] advised 50 mg. pyribenzamine by mouth thirty to forty-five minutes before the injection, feeling sure of its beneficial effects. Crepea, Allanson and DeLambre[8] found no beneficial effects from 100 mg. of pyribenzamine given by mouth one hour before the injection. Wheras the evidence favoring the use of antihistaminics seems encouraging, much more must be done before conclusions can be drawn.[1,2,20,22,28,31]

It is well to remember that 25 "immediate" deaths in 3,831,850 urograms represents a very small risk. One must weigh carefully anything that might possible increase this risk. Gammon[14] found that benadryl and other antihistamine agents induced convulsions when used intravenously in patients selected with suspected petit mal. Perhaps other untoward responses will be found as intravenous antihistaminics are used more freely. Thus it is we feel that it may be best to administer antihistaminics orally rather than intramuscularly or intravenously.

Until now we have not used antihistaminics routinely for intravenous urography. Our plan now is to give antihistaminics by mouth (chlor-trimeton maleate, 4 mg.) at bedtime the evening before the examination, and a second dose one hour before the urogram is started. In so doing we wonder whether the sedative action of the drug may not prove just as important as its antihistaminic effect.

Care of Reactions. (Table XVII.) The treatment will continue to be symptomatic until more is known concerning their cause and the pathologic physiology. When reactions develop they may do so with explosive suddenness. One must know beforehand what to expect, what to look for, and how to counteract it (Table XVII). In hospitals proper liaison can be established between the departments of anesthesiology and radiology to assure efficient handling of the emergency. In private offices of physicians this will be more difficult but merits equal consideration.

When the reaction develops, help should be sought immediately. Without leaving the patient, selected physicians, nurses or technicians must be rallied at once. In our department an alarm is broadcast over the

* The following statement taken from New and Nonofficial Remedies published in 1952, page 276, that "ocular, oral, and intradermal tests to detect sensitivity to intravenously administered iodine compounds are not reliable since reactions are more often due to direct vascular effect" merits careful recognition.

TABLE XVII

EMERGENCY DIRECTIONS FOR REACTIONS TO INTRAVENOUS OR INTRA-ARTERIAL CONTRAST MEDIA (DOSES FOR ADULTS), HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA

BROADCAST-DEPARTMENT LOUD SPEAKER: "Red alert, Room _____"

TELEPHONE: Anesthesia Department, Ext. Number 205, 206.

1. IMMEDIATELY start 100% oxygen
2. IMMEDIATELY start intravenous fluids (PSS—5% glucose)
3. Give *intravenously* depending upon signs or symptoms the following:
   - A. For severe apprehension, severe restlessness, convulsions:
     Seconal sodium or thiopental sodium intravenously, 25–50 mg.
   - B. For allergic symptoms:
     Benadryl, intravenously 20 mg.
   - C. For hypotension (sweat, pallor, poor capillary refill, air hunger):
     Neo-synephrine, intravenously 0.2–0.5 mg.

   If no appreciable rise in blood pressure in 1 minute;
   l-nor-epinephrine (levophed), intravenously as a drip, 4 mg. diluted in 500 cc. of PSS, H_2O, or 5% glucose

NOTE: For children under 12, scale dose proportionately

WARNING: Do not use epinephrine (adrenalin) as it induces ventricular fibrillation in the presence of anoxia

WARNING: All respiratory stimulants are contraindicated because they may cause convulsion

intradepartmental loud speaker. At the same time the anesthesia department is notified by telephone, and almost simultaneously, by radiologic personnel, 100 per cent oxygen is started, using a mask with a breathing bag. It is the anoxia that is dangerous to the patient's life; it must be actively combated from the outset. If necessary the bellows type resuscitator must be used.

While oxygen is being administered, intravenous fluids should immediately be started to support the patient's circulation. The intravenous needle should be kept in the vein, even though a "cut-down" is necessary, as this affords an avenue for easy intravenous administration of drugs. Unless this is done at once, valuable time may be lost looking for veins when they have collapsed. Any fluid may be used intravenously, providing it is sterile. This means sterile solutions and sterile auxilliary apparatus must always be in the room when the patient is being examined. There is no time to hunt for oxygen, there is no time to look for drugs.

Having started oxygen and intravenous fluids, one must then decide whether it is apprehension and convulsion, allergy, or hypotension that is the immediate threat. Usually restlessness, anxiety and confusion presage the untoward sequelae; convulsions may develop at the same time. For these symptoms the barbiturates, seconal sodium or thiopental sodium, given intravenously, are particularly useful. Seconal sodium may be purchased in ampoules ready for immediate use; thiopental sodium is dispensed as a vial which must be properly diluted before it can be used. Either drug given intravenously, 25 to 50 mg., depending upon the size of the patient and violence of the reaction, should suffice.

Should the reaction pattern indicate histamine release with sneezing, flushing, urticaria, itching, or wheezing, benadryl (20 mg.) should be given intravenously, irrespective of whether or not the patient received antihistaminics previously. There is some question whether antihistaminics given in the face of sudden histamine release do good. The evidence suggests the benadryl might be helpful; under the circumstances, it probably can do no harm.

Cardiac distress and hypotension are easily recognized as a rule. Sweating, pallor, air hunger, a thready pulse, poor capillary refill are the cardinal symptoms. The best and easiest index is the patient's pulse. It should be followed carefully—before, during, and after the injection—care being taken to recognize changes in rhythm and volume. A running conversation with the patient is extremely useful for it will often lag or be interrupted as reactions develop. The ordinary blood pressure cuff also is a valuable tool.

For hypotension, neo-synephrine hydrochloride 1 per cent solution should be used intravenously. Depending upon the state of the patient's circulation, the dose may vary between 0.2 to 0.5 mg. given intravenously. If no appreciable rise in blood pressure is observed within one minute, l-nor-epinephrine (Levophed, Winthrop-Stearns, Inc.) should be used intravenously as a drip, 4 mg. being diluted in 500 cc. of physiological salt water, or 5 per cent glucose. Should the blood pressure rise precipitously, a pearl of amyl nitrite may be used to counteract its constrictive effects.

In view of the explosive nature of the alarming reactions to intravenous contrast media, an emergency tray must always be available for immediate use. Everything must be sterile, all solutions easily identified and ready for immediate use, and all auxiliary equipment should be at hand. Obviously the emergency set-up must be constantly checked and resterilized every ten to fourteen days.

In our department, the following are found on the emergency tray:

Seconal sodium
Thiopental sodium
Benadryl
Neo-synephrine hydrochloride
l-nor-epinephrine (levophed)
Amyl nitrite
Six needles of varying lengths.
Syringes
Tourniquet
Knife
Gloves
Forceps and retractors.
Endotracheal airway

Also immediately available are the following accessories:

100 per cent oxygen and mask
Intravenous set and solutions
Suction apparatus
Blood pressure apparatus
Stethoscope
A chart briefly showing dosage of drugs, the necessary dilutions and the indications for each

Two warnings merit careful consideration in patients who develop severe reactions: (1) the use of adrenalin chloride solution, and (2) the use of respiratory stimulants. Adrenalin chloride should not be used in the presence of anoxia—it will induce ventricular fibrillation. The respiratory stimulants (metrazol, picrotoxin, nicotinamide) are also contraindicated because they may cause convulsions.

It is not within the province of this discussion to record in detail the many drugs, other than those presented already, that can be used for these emergencies. In our hospital we rely upon our Department of Anesthesiology which has told us what we should do and whose staff are available immediately when trouble develops. The emergency directions for reactions to contrast media outlined in Table XVII include their suggestions.[10,11,31] It has been planned with the understanding that they will be notified at once and will assume charge of the problem upon their arrival in the Department of Radiology. Until they arrive one physician must take charge and direct the treatment.

No discussion of this problem would be complete without mention being made of cardic arrest and its treatment. According to Kirby[18] "classical cardiac arrest" probably will not often occur in these individuals. Although Kirby has had no personal experience with these emergencies, his evaluation of the case histories has led him to this conclusion. Should the heart suddenly stop beating, which is what happens in cardiac arrest, there is nothing to do do but open the chest and massage the heart. The decision to do so must be made and the massage started within three minutes or all is lost. Whether this is the radiologist's responsibility will depend upon where and under what circumstances the reaction developed. In our department, pounding the chest wall seemed to stimulate cardiac activity on several occasions; it is well worth trying.

SUMMARY

Thirty-one deaths (not already recorded in the literature) following the intravenous administration of contrast media for the

study of the urinary tract have been collected. Twenty-five deaths occurred immediately and six were delayed or indeterminate. These deaths have occurred over an eleven-year period (1942 to 1952 inclusive) in a series of approximately 3,800,000 urograms. *The incidence of deaths is exceedingly low.* During this period only two deaths have been reported in the literature.

The "immediate" deaths were preceded by symptoms of dyspnea, cyanosis, hypotension and convulsions.

Negative hypersensitivity tests are not reliable. In fifteen of the twenty-five "immediate" deaths, the sensitivity tests were interpreted as being negative. It is generally believed that careful history with particular emphasis on allergy is important. Many combine this information with one of the sensitivity tests and, in the presence of a positive test and a strong allergic history, the procedure of urography is not recommended. There is a definite trend toward the use of antihistaminics before or during the procedures of urography.

Finally, a brief discussion is included concerning current ideas about the reactions to contrast media, the allergy problem and preventive measures. It is concluded that many mechanisms of the mild and severe reactions are not understood and that further clinical and fundamental research is not only desirable but essential.

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KIDNEY LESIONS IN EXPERIMENTAL HYPERVITAMINOSIS D*

A MICRORADIOGRAPHIC AND MICROANGIOGRAPHIC STUDY

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STOCKHOLM, SWEDEN

INTRODUCTION

THE administration of large doses of the vitamins D causes injuries in many organs both in man and in experimental animals. Agduhr (1926) described severe damage in the heart and other organs of mice following the administration of large doses of cod liver oil. The effects of drugs containing vitamin D were later studied by other authors, *i.a.*, Pfannenstiel (1928), Kreitmair and Hintzelmann (1928), and Herzenberg (1929). The lesions described by these authors are characterized by degeneration, necrosis and precipitation of calcium salts in various tissues and organs such as heart, muscle, blood vessel walls, lungs, stomach, and kidneys.

The large arteries, and above all the aorta, are damaged early in vitamin D intoxication. The blood vessel wall is thick and stiff; the inner surface is rough. Localized dilatations of the aneurysm type are often observed. The injury is localized primarily in the media, in which the elastic fibers are fragmented, and the smooth muscle fibrils show degeneration and necrosis. There are deposits of calcium salts between the elastic lamellae (Varela *et al.*, 1929). In some advanced cases, the lumina are narrowed by intima cell proliferation.

Apart from the large blood vessels, the kidney is the organ most commonly injured in hypervitaminosis D, and very often kidney failure is the cause of death of animals given large doses of vitamin D. Renal failure has also been described in man after treatment with very large doses of vitamin D for long periods (Danowski, Winkler and Peters, 1945, and others). The lesions in the kidneys of experimental animals are characterized by marked degenerative changes and heavy deposition of calcium salts. The latter are found in the blood vessel walls and the glomeruli, in the tubules, and also in the interstitial tissue. The smallest arteries and arterioles often show marked changes, sometimes with obliteration of the lumen (Handovsky and Goormaghtigh, 1935). In some cases there are precipitates of calcium salts in the capsule of Bowman, and the glomerular tufts may be collapsed. The tubules are often distended and filled with hyaline and calcium casts. Precipitation of calcium salts around the tubules may also be observed, and these precipitates are rather well localized in the inner half of the cortex. The kidney damage shows similar features in both man and animals. Von Brand and Holtz (1929), from studies of experimental hypervitaminosis D in rabbits, have suggested that in the kidney the first damage is to the blood vessels, but in the case of rats it has been shown that the damage to blood vessels comes at a later stage.

Using ordinary histological methods only qualitative information on the damage to blood vessels and soft tissue can be obtained. However, more quantitative information may be obtained by applying the microradiographic and microangiographic techniques. These methods are at present being applied in an extensive study of blood vessels and blood vessel damage associated with various pathological conditions. This paper reports observations on the kidney damage associated with hypervitaminosis D.

METHODS

Twenty albino rats, weighing between 150 and 200 grams, were given 0.5 mg. of pure vita-

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min D_2 daily by stomach tube. Weight loss started after five to seven days, and the animals were killed after ten days.

Fifteen mature rabbits were given subcutaneously 7 mg. of vitamin D_2 daily. Weight loss started after about fourteen days, and the animals were killed within twenty-one days.

In all cases the abdomen of the animal was opened under ether anesthesia, and both kidneys were removed. The right kidney was immediately fixed in neutral formalin. The left kidney was placed in warm 0.9 per cent saline, and radiopaque contrast medium (fresh 20 per cent neo-protosil solution with 3 per cent egg albumin) was injected through the renal artery. An indication of the extent of displacement of blood was given by the white coloring from the contrast medium, and the filling of the superficial capillary net was observed in a microscope during the injection. At the end of the injection, ligatures were placed on the blood vessels of the kidney, and this was then fixed in a special fixative containing formalin, alcohol, picric acid, acetic acid and chloroform. The injected specimens were fixed for several days before cutting for embedding and sectioning. The fixed contrast medium adhered to the opened blood vessels.

Specimens from both kidneys were embedded in beeswax, and sections 200 micra thick obtained for microradiography. These were mounted on thin mica sheets and stereo-microradiographed using the radiation from a North American Philips diffraction tube with copper target and beryllium windows, as described by Bellman (1953). The high voltage was 25 kv. (peak), which gave a short wave limit of 0.5 Å for the roentgen rays. Contrast filled blood vessels and calcium deposits in the tissue gave high absorption of these roentgen rays. The embedded tissue itself gave a rather low and almost uniform absorption. The structure of the soft tissue was also studied by microradiography with softer roentgen rays. For this purpose the thick section was re-embedded in beeswax or paraffin, and sections 10 micra thick were cut. These were mounted on thin foils of cellulose acetate, deparaffinized, and microradiographed in vacuo with the apparatus described by Engström and Lindström (1950). The high voltage was 4 kv., and the roentgen rays were filtered through 9 micra aluminum, giving a roentgen spectrum with the maximum intensity between 8 and 12 Å.

The primary microradiograms were recorded on Eastman Kodak M.R. Plates or on Gevaert Lippmann Film. The resolving power of the emulsions was about 1 micron. The magnification was obtained by photomicrography, and the photomicrographs were reversed so as to give positive final pictures in which roentgen-ray absorption showed black.

Histological examination of the tissue was carried out using standard methods. Sections were also stained according to Ladewig and to Hotchkiss. Calcium salts were demonstrated by alizarin staining (Dahl, 1952).

RESULTS

The kidneys of the vitamin D intoxicated animals appeared abnormal even by gross examination. They were swollen and the surface showed a dappled yellow-brown color. Detailed examination of the individual structures within the kidney revealed appreciable damage.

The Blood Vessels. The interlobular arteries and the afferent arterioles showed irregularly shaped dilatation throughout their length. Occasional constrictions were also observed (Fig. 1*B*). Dilatation and constriction of an even more pronounced nature were usually observed in the vasa recta both in rats and in rabbits (Fig. 5*B*). Excessive calcification of the arteries was often seen in rabbits (Fig. 4) but never in rats. In a few rabbits there was a very great dilatation of the intertubular capillary net (Fig. 6*B*).

The Glomeruli. In many cases the glomeruli appeared normal by histological examination. However, the filling of the glomeruli with contrast medium in microangiographic experiments was invariably found to be incomplete (Fig. 1*B*). The penetration of the contrast medium was only into the vascular pole. Such incomplete filling has also been observed in exceptional cases with normal kidney, particularly in the case of the rabbit. Swelling and hyalinization of some of the glomerular tufts was often observed (Fig. 8). Such tufts contained relatively little blood. Red blood cells, contrast medium, and additional exudate were often found in the subcapsular

FIG. 1*A*. Microangiogram (×20) from a 200 μ section of a normal rabbit kidney injected with 20 per cent neo-protosil solution. The interlobular arteries and the afferent arterioles are filled, and the glomeruli contain varying amounts of contrast medium. The filling tends to decrease towards the efferent vessel, which is not filled. Filling of the intertubular capillaries is also seen.

FIG. 1*B*. Microangiogram (×25) from a 200 μ section of the kidney of a rabbit given vitamin D_2, 7 mg. per day for 21 days; 20 per cent neo-protosil was injected into the renal artery. The interlobular arteries are distended and irregular, and the afferent arterioles show dilatation and constriction. The filling of the glomeruli does not differ from that occasionally seen in normal kidneys. Patchy filling of the capillary net can also be seen.

FIG. 2*A*. Microradiogram (×15) from a 200 μ section of an uninjected kidney from an albino rat which had been given 0.5 mg. vitamin D_2 daily for 10 days. Massive casts of calcium salts can be seen in tubules in the inner part of the cortex.

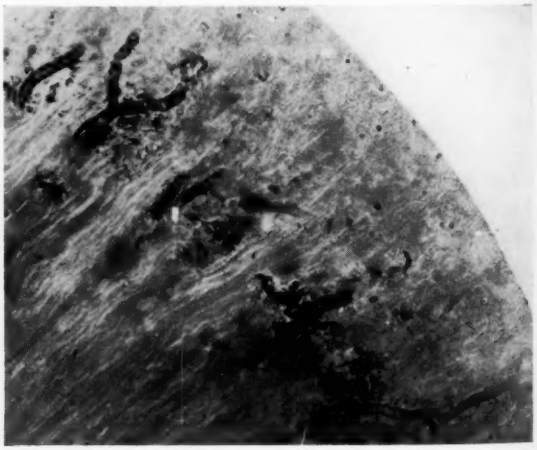

FIG. 2*B*. Microradiogram (×15) from a 200 μ section of an uninjected kidney of a rabbit given 7 mg. vitamin D_2 daily for 21 days. The illustration shows calcification of the proximal parts of the interlobular arteries and rather dense calcifications in the inner zone of the cortex. A few small calcifications are also seen in the outer part of the cortex.

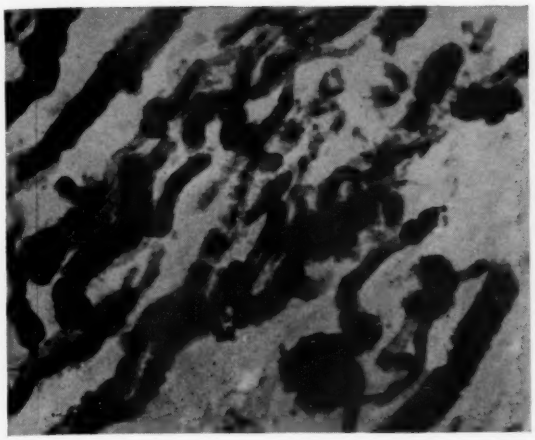

Fig. 3*A*. Microradiogram (×70) from a 200 μ section of an uninjected kidney of a rat which had been given 0.5 mg. vitamin D_2 per day for 10 days. Calcium salt casts are shown in the inner zone of the cortex.

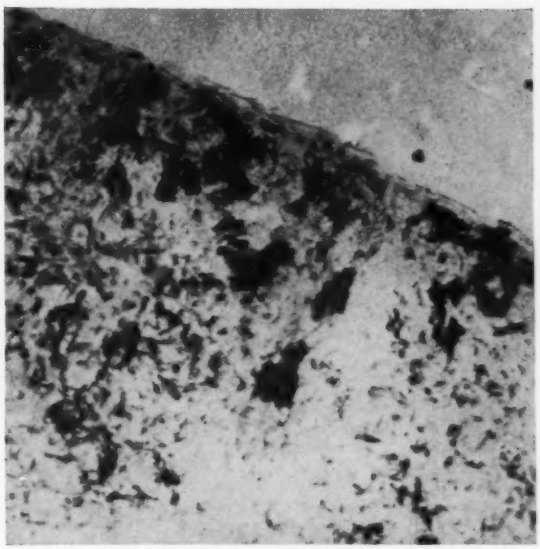

Fig. 3*B*. Microradiogram (×80) from the same specimen as in Figure 3*A*. Small calcifications can be seen in the interstitial tissue and calcium salt casts near the surface.

space (Fig. 7), probably indicating an abnormal permeability of the tufts. In some cases, especially in rabbits, an excessive calcification was observed in the capsule of Bowman (Fig. 4).

The Tubules. Distended tubules with flattened epithelial cells were found in almost every section. Hyaline drop degeneration and calcium salt deposition were frequently observed in the tubular epithelium (Fig. 7–8). In rat tubules a few scattered hyaline casts were seen, and a large number of calcium salt casts. The latter were found mainly in a well defined zone in the inner part of the cortex but with a few small deposits near the surface (Fig. 2*A*, 3*A* and 3*B*). The rabbit tubules showed a few small and widely scattered casts of calcium salts, and an occasional hyaline cast in the deep zone of the cortex (Fig. 2*B*).

The Interstitial Tissue. In the cortex there were small areas of fibrosis in the interstitial tissue and infiltration of round cells. Extensive deposition of calcium salts was also found. In rats there was a dense deposition throughout the outer zone of the cortex, the deposits being grouped in closely spaced patches (Fig. 2*A*). These patches appeared to coincide with the areas of fibrosis. In rabbits the deposits were confined to the inner zone of the cortex and concentrated around the interlobular arteries (Fig. 2*B*).

DISCUSSION

A characteristic feature of the microangiograms was the incomplete penetration of contrast medium into the glomerular

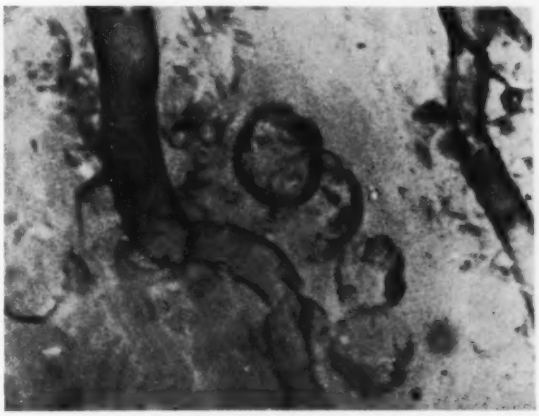

Fig. 4. Microradiogram (×80) from a 200 μ section of a rabbit kidney after the administration of 7 mg. vitamin D_2 daily for 21 days. Calcium salt deposits can be seen in the walls of interlobular arteries and in the capsules of Bowman. The picture is from the inner part of the cortex.

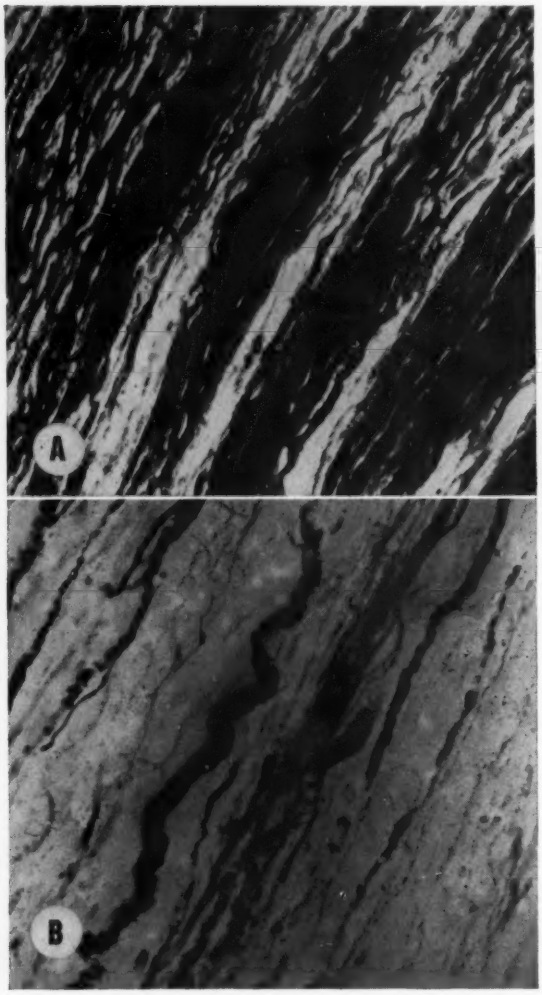

Fig. 5. Microangiograms (×85) from (*A*) a normal rat kidney, and (*B*) the kidney of a rat given 0.5 mg. vitamin D_2 for 10 days. Contrast medium: neo-protosil. The section thickness was 200 μ. The vasa recta in the vitamin D intoxicated kidney differ greatly from the normal bundles of vasa recta seen in (*A*).

tufts. It is possible that this finding is related to some anatomical change in the blood vessels which causes a narrowing of the lumen. A hyalinization of the glomerular tufts and obliteration of the lumina were in fact observed histologically in some of the experimental animals. However, the fact that a similar incomplete filling can be observed in normal kidney, which shows no anatomical changes, might suggest that the phenomenon is associated with a functional change, probably with a vascular spasm.

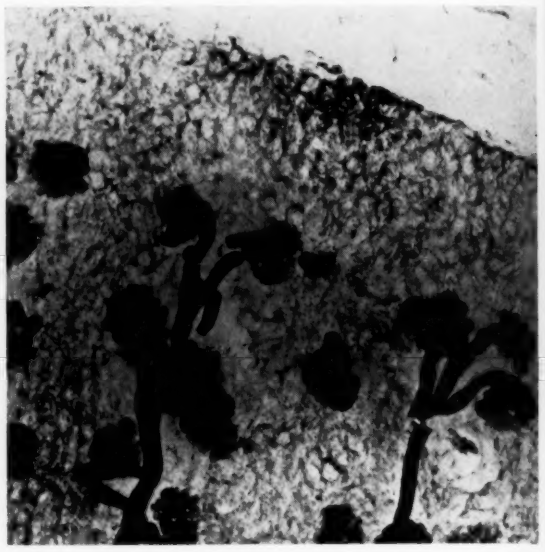

Fig. 6*A*. Microangiogram (×90) from a normal rabbit kidney (the same specimen as Figure 1*A*). The proximal parts of the glomeruli contain contrast medium. Contrast medium can also be seen in the intertubular capillaries.

Such vascular spasm, occurring in the efferent vessels, would also provide a possible explanation for the observation that the proximal part of the anatomically nor-

Fig. 6*B*. Microangiogram (×90) from a 200 μ section of a kidney from a rabbit which had been given 7 mg. vitamin D_2 per day for 21 days. Contrast medium: neo-protosil. Contrast medium can be seen in the subcapsular space of the glomeruli. The intertubular capillaries are markedly dilated.

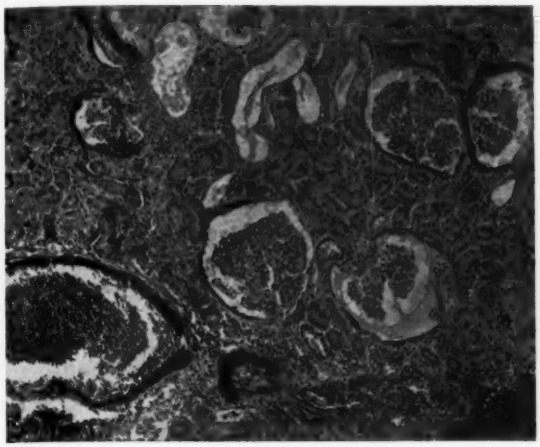

Fig. 7. Hemotoxylin-eosin stained 5 μ section (×70) from the kidney of a rabbit given 7 mg. vitamin D_2 per day for 21 days. The interlobular arteries are widened and calcified as is also the capsule of Bowman. In the right lower corner there is an accumulation of round cells. Some tubules are distended.

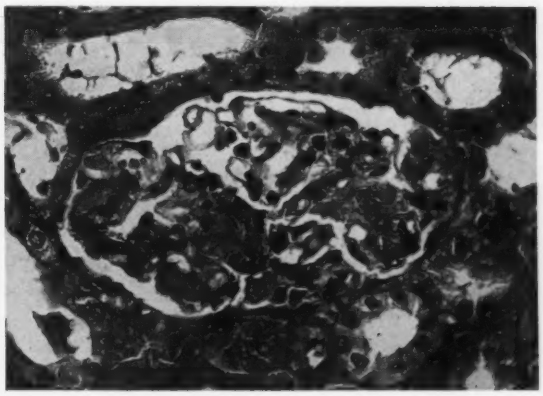

Fig. 8. Ladewig-stained 5 μ section (×280) from the kidney of a rabbit treated as described for Figure 7. The glomerular tufts show marked hyalinization and hyaline drop degeneration can be seen in the tubular epithelium.

mal tufts was distended by the contrast medium while the remainder contained apparently normal red blood corpuscles. This interpretation would probably imply that the tendency for spasms to occur in the small arteries of the kidney is increased by the vitamin D intoxication.

The observed hyalinization of the glomerular tufts showed marked similarities to kidney lesions seen in man and described as intercapillary glomerulosclerosis. This anatomical change is often found in the nephrotic syndrome, and here the hyaline drop degeneration of the tubules is also observed.

Damage to all types of structures within the kidney has been demonstrated in vitamin D intoxication. The extent of injury varied both in the rat and in the rabbit but marked differences were observed both in extent and type of injury between the two species. The main damage appeared to be in the glomeruli and the tubules of the rat but in the glomeruli and the blood vessels of the rabbit.

SUMMARY

Hypervitaminosis D causes kidney lesions. These lesions have been studied in the rat and in the rabbit using histological, microradiographic, and microangiographic methods. Anatomical changes observed in the glomeruli were similar to those described as intercapillary glomerulosclerosis in man. Blood vessels such as the interlobular arteries, the afferent arterioles, and the vasa recta were often found to be dilated. The microangiograms suggested the occurrence of spasms in the efferent arterioles. Calcium deposition was found in all structures. Variations in extent and type of injury were shown.

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HIGH ECTOPY OF THE LEFT KIDNEY

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HIGH ectopy of the kidney is a rare condition. In a review of the literature by Campbell[5] (1930) 7 such cases were found, all of them being discovered on postmortem examination. In 13,000 autopsies at the Bellevue Hospital 24 renal ectopies were found by the same author, and among them was one high ectopy. There is a prevalence for the left side (6:3) in the reported cases. This ratio becomes less prominent (7:5), however, if those cases are not omitted where injury might have had a role in the displacement of the kidney. Barrett[2] was probably the first (1945) to report a proximally displaced kidney in a living person. He found a shadow on the right hemidiaphragm, which was interpreted as a tumor of either the diaphragm or the chest wall. Surgery disclosed the displacement of the right kidney through an opening of the diaphragm into the right hemithorax. The displacement was believed to be the result of an injury which was inflicted by a narrow knife twenty-six years before. Bell, Heublein and Hammer[3] also report a case of "herniation" of the right kidney through the diaphragm—thought to be traumatic in origin; the diagnosis was made by surgery. Fleischner, Robins and Abrams[6] (1950) report a high ectopy of the right kidney diagnosed by excretory urography; this is probably the first case identified in a living person by methods other than surgery. More recently Rubin,[10] Spillane and Prather,[12] Williams and Tillinghast,[13] Bugden[4] and Ritvo[11] reported cases of high ectopy of the kidney discovered either by roentgen examination or on surgery.

The discovery of high renal ectopy has increased in frequency during the last few years. This has been made possible mostly by routine chest surveys performed on large segments of the population. It is interesting to note that this is in contrast with the low rate of discovery of lumbar and sacral ectopies, of which approximately 9 out of 10 remain undiscovered during life (Gondos[7]).

CASE REPORT

E.H., male, aged forty, had a "routine" chest roentgen examination in the Civilian Dispensary of the U. S. Army, in The Pentagon. On this occasion a rounded homogeneous density was discovered adjacent to the posterior aspect of the left hemidiaphragm (Fig. 1 and 2). On roentgenoscopy this density could not be separated from the shadow of the diaphragm. It showed slight respiratory excursions, but they were less in extent when compared with those of the diaphragm itself. It was our impression that the respiratory movements of the "mass" were independent from those of the diaphragm. Pleuroperitoneal hernia of the diaphragm or high ectopy of the left kidney

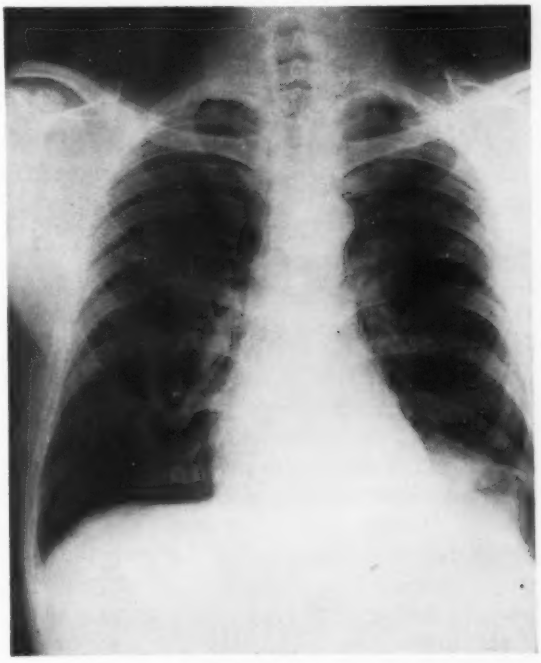

FIG. 1. Roentgenogram showing sharply outlined density obscuring the base of the left lung.

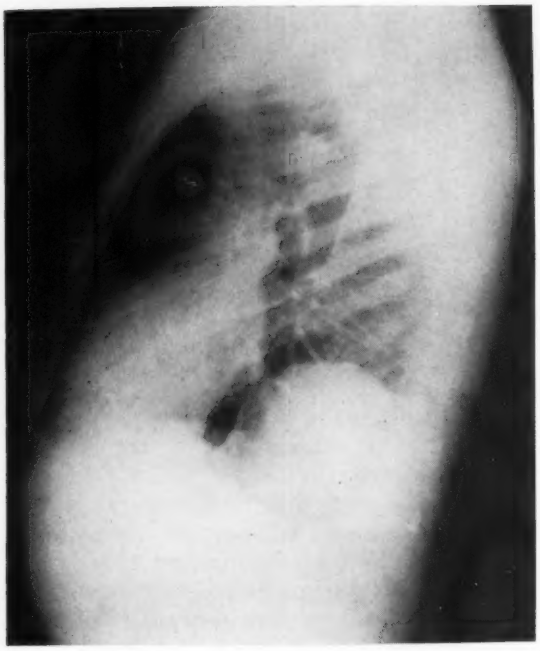

Fig. 2. Lateral roentgenogram reveals a rounded "mass," located posteriorly.

were the suggested diagnoses. The latter possibility was supported by the anteroposterior film of the abdomen, on which no left kidney shadow in the usual place was visualized; on the other hand, the shadow adjacent to the left hemidiaphragm apparently extended below the level of the diaphragm.

First, excretory urography was performed. The urograms showed that the mass seen above the left hemidiaphragm represented a part of the left kidney. The kidney pelvis was located anteriorly and the calyces were in part directed medially. The long axis of the ectopic kidney showed convergence toward the midline, the lower pole being deviated medially. These films also revealed an old compression fracture of the second lumbar vertebra, and a deformity of the pelvis, apparently the result of an old healed fracture. The bones showed uniform moderate osteoporosis (Fig. 3). Roentgen examination of the gastrointestinal tract revealed no herniation of the gastrointestinal organs through the diaphragm. The patient had a personal and family history of osteogenesis imperfecta. Beginning in early childhood, he had several fractures in various parts of the lower extremities. He also showed the two other features of this syndrome, namely blue scleras, and deterioration of his hearing since 1944. The patient had an accident in 1944, being thrown from an automobile and sustaining a fracture of the pelvis. This fracture healed without any sequelae. In another accident, one year later, he was hit by an automobile and fractured his right wrist, both shoulders, ribs, and the pelvis. Following these injuries there was no history of any chest or upper abdominal pain, no respiratory embarrassment or hematuria. One month prior to the present investigation, the patient had an episode of left-sided chest pain lasting ten to fifteen minutes. Physical examination and electrocardiographic studies were negative except for the manifestations of otosclerosis mentioned before. The patient has been without symptoms since this episode.

DISCUSSION

Two cases have been found in the literature wherein thoracic dystopy of the kidney was attributed to a previous injury. This possibility was considered also in our case in view of the two serious automobile accidents seven and eight years before, respectively. Following the accidents there was no clinical or laboratory evidence of renal injury. It was assumed that such a traumatic displacement of the kidney is very

Fig. 3. Intravenous urogram. The rounded density above the left hemidiaphragm represents a part of the ectopic left kidney. Note that the long axis of the ectopic kidney converges toward the midline.

unlikely to occur without serious injury of the kidney parenchyma. Trauma as a causative agent was discarded and this condition was thought to be the result of faulty development. According to Spillane and Prather[12] the following three criteria are essential for a diagnosis of high ectopy of the kidney: (1) rotation anomaly; (2) long ureter, and (3) anomalous high derivation of the renal vessels. Our urograms demonstrated the first two requirements—the lack of medial rotation of the left kidney pelvis and the abnormally long left ureter. It is known that lumbar and sacral ectopies are generally associated with a rotation anomaly, though this may also occur in otherwise normal kidneys. The abnormally long ureter in high ectopy of the kidney can be compared with the short ureter of lumbar and sacral ectopies. No information could be obtained in reference to the third requirement on the basis of the present examinations, but this—namely, the question of high origin of the renal vessels—was considered to be only of academic significance. We wish to mention here that a medial deviation of the lower pole of the ectopic kidney may also be observed. It was demonstrated not only in the case presented here, but similar findings have been reported by Kleine,[9] based on observations at autopsy. These findings are in contrast with the normal anatomy of the kidneys in which the axes diverge in the caudal direction.

The developmental aspect of high renal ectopy has been a subject of discussion in the literature. In the early fetal life the kidney (metanephros) develops in the floor of the small pelvis. The ureter grows out of the caudal end of the wolffian duct and subsequently it contacts with and grows into the metanephrogenic tissue. Simultaneously with this process, an ascent of the kidney is taking place. The kidneys occupy their approximate final position at about the sixth week of fetal life. Any disturbance in the ascent of the kidney may result in a low position (*i.e.*, in lumbar or sacral ectopy). It is believed that in such cases a premature differentiation of the primitive kidney occurs. This is possibly due to a premature ingrowth of the primitive ureter into the metanephrogenic tissue. The premature differentiation would result in an earlier conclusion of the ascent of the kidney and in a consecutive low ectopy. This theory may be applied to high ectopy as well, if we assume that a delayed ingrowth of the ureter into the metanephros occurs. This would result in a diminished stimulus to the metanephrogenic tissue, with a consecutive delay in its differentiation. The consequence would be a prolongation of the ascending process, resulting in high renal ectopy and in an abnormal length of the ureter.

Parallel with the ascent of the kidney a complicated development of the diaphragm is taking place. The membranous diaphragm develops from four parts. The largest (anteromedial) part develops from the septum transversum, representing the caudal portion of the fetal pericardium. The posterolateral segment on each side develops from the pleuroperitoneal membrane, whereas the posteromedial part originates from the dorsal mesentery. The fourth contribution to the membranous diaphragm is supplied by the body wall (Arey[1]). The pleuroperitoneal membrane has an opening called the pleuroperitoneal canal, which connects the primitive pleural and peritoneal cavities. After a gradual decrease in size, this canal is closed in the seventh or eighth week of the fetal life. If the closure is incomplete, a defect of various size remains in the posterolateral aspect of the diaphragm, on the respective side. Through this opening, abdominal organs protrude into the thoracic cavity and a false hernia develops. This condition should be differentiated from the so-called Bochdalek hernia. The latter develops in the area where the lumbar and costal portions of the muscular diaphragm meet, and a membranous portion remains. As a result of the intra-abdominal pressure, a hernia may develop through this weak point into the thoracic cavity. In contrast to the first mentioned congenital condition, this is considered an acquired true hernia, with a hernial sack consisting of the parietal pleura and peritoneum. False hernia most

commonly occurs through this area of the diaphragm (Harrington[8]). High ectopy of the kidney is not a hernia, not even a false hernia. In this respect it can be compared to the thoracic stomach having a congenitally short esophagus, which has nothing to do with the hiatus hernia. Kleine[9] points out that under normal circumstances the ascent of the kidneys terminates earlier (fifth to sixth week of fetal life) than the closure of the pleuroperitoneal canal (seventh to eighth week of fetal life). This leads him to the conclusion that high position of the kidney is the primary factor, and the defect of the diaphragm is the secondary one. Fleischner, Robins and Abrams[6] assume that a disturbance in the involution of the mesonephros and a delay of its caudal migration with the adrenal may be the primary developmental failure. In view of these theories, I refer to a case reported by Rubin[10], in which high ectopy of the left kidney was discovered; its appearance was similar to ours as seen on the roentgenogram. Surgery disclosed that the diaphragm above the displaced kidney was "thin and atrophic," but no defect of the diaphragm was evident. This finding indicates that a defect of the diaphragm is not necessary for the development of high ectopy of the kidney. This seems to support Kleine's theory outlined above. This finding is also in accordance with Campbell's suggestion that high ectopy of the kidney is the result of an abnormally high origin of the renal vessels from the aorta. In this respect, it can be compared to the lumbar and sacral ectopies, where the renal vessels originate at a lower level of the aorta or of its branches.

The diagnosis of this condition is sometimes difficult and, on the basis of incorrect diagnosis, performances of unnecessary surgery have been reported in the literature. A diagnosis of tumor of the diaphragm, Bochdalek hernia, neurofibroma, or pericardial cyst can erroneously be made. Diagnostic pneumothorax as a means for differentiation has been repeatedly mentioned in the literature. If the possibility of high ectopy of the kidney arises, however, the correct diagnosis can be made with relative ease by excretory urography and by examination of the gastrointestinal tract with barium suspension.

SUMMARY

A case of high ectopy of the left kidney is reported. It was discovered on a routine chest roentgen examination and has been subsequently identified by intravenous urography. This condition is not considered a hernia, and a defect of the diaphragm has probably no causative role in its development.

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HEREDITARY HEMORRHAGIC TELANGIECTASIS WITH INVOLVEMENT OF BONE*

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HEREDITARY hemorrhagic telangiectasis (Osler-Weber-Rendu disease) is comparatively rare, although it occurs more frequently than is commonly supposed.[5,11,15,19] It is manifested clinically by the presence of telangiectases and small hemangiomas which tend gradually to increase in number. Hemorrhages frequently begin in childhood and continue to recur during adult life. Bleeding is not due to defects in the blood clotting mechanism or to circulatory disturbances, but is apparently due to the local vascular condition. The disease affects both males and females of successive generations.

In Osler's[16] original description of this disease in 1901, the lesions were noted only in the skin and mucous membranes. Later authors described visceral involvement as well. The organs affected include the lungs,[6,10,12,15] the intestines,[3,11,14] the brain,[21] the eyes,[9,17] the genitourinary organs,[2,8,13] and the liver and spleen.[1,7,18] In 1947 Goldstein[11] and in 1948 Moyer and Ackerman,[15] in reviews of the literature, found many different sites in which lesions occurred. However, they found no case in which the bones were involved. A thorough search of the literature through 1952 has failed to reveal any cases with bone lesions. We therefore consider it of interest to present a case of hereditary hemorrhagic telangiectasis in which there were angiomas in the bones which produced symptoms requiring treatment.

In general, angiomas of the bones are supposed to be rare, and are not often seen in roentgenologic studies.[4] On the other hand, Töpfer[20] found angiomas in 11.9 per cent of 2,154 spines examined at autopsy. Included in his material were lesions probably too small to be visualized on the roentgenogram. During the past twenty years, 15,437 patients were seen at the Radium and Tumor Institute of the Hadassah University Hospital in Jerusalem. Among them were 873 patients with skin angiomas and only 9 with bone angiomas. There were, in addition 4 cases of hereditary hemorrhagic telangiectasis, including the present case with both skin and bone angiomas.

CASE REPORT

D. A. was a Russian-born Jewish housewife, aged sixty-five. Her mother had frequent epistaxes, and had dark spots on her tongue, but apparently did not have any skin lesions. One brother and one sister have had frequent epistaxes, but two brothers have had none. A son has had epistaxes, but two daughters have not had any.

The patient's first epistaxis occurred at the age of ten. Bleeding in the beginning was daily, but has gradually decreased in frequency and now occurs one to three times a month. Thirty-two years ago the vision in the left eye suddenly became blurred. An ophthalmologist found evidence of choroidal bleeding. Vision improved, but seven years ago there was an episode of blurring of vision of both eyes. Since then, vision in the left eye has remained blurred, but vision in the right eye is fairly good.

Ten years ago the patient first noted the appearance of small dark spots on her upper trunk and arms. These bled after minor trauma. Since then the spots have increased in number. Recently the patient began to have severe continuous occipital and temporal headache.

The menses began at the age of thirteen, and were always regular and the flow normal in amount. She passed the menopause at the age of fifty-one. Except for epistaxis, there has been no bleeding from the body orifices.

Physical examination showed a well developed woman, apparently in good health.

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Fig. 1

There were small telangiectases on the face and small angiomas on the skin of the trunk and upper extremities which blanched under pressure. The angiomas ranged in size from 1 to 2 mm. in diameter (Fig. 1 and 2). The right fundus showed a paracentral area of old chorioretinitis and the left fundus showed choroidal atrophy, both apparently post-hemorrhagic in origin. There was no evidence of recent bleeding. Telangiectases were present in the nares, and there was bleeding from the area of Kiesselbach on the right. On the anterior part of the tongue there were many pinpoint red spots. The blood pressure was 135/100 mm. Hg, and the heart rate and rhythm were normal. No murmurs were heard. The lungs were clear. The liver and spleen were not palpable. There was tenderness to percussion over the following bones: C6–8, Th7–8, and L1–5 vertebrae, ribs 5–7 in the right axillary line, both clavicles and the right coracoid process.

The urine occasionally showed traces of albumin. Blood count: 4 million erythrocytes, 13 gm. per cent of hemoglobin, 5,300 leukocytes with normal differential count, platelets 192,000. The bleeding time was 2.5 minutes and the clotting time 6 minutes. The Rumpel-Leede test was negative, and the osmotic fragility was normal. Blood urea, glucose, and serum cholesterol, total protein, albumin, globulin and chlorides were within normal limits. Serum calcium 8.8 mg. per cent, phosphorus 3.7 mg. per cent and alkaline phosphatase 3.9 Bodansky units. Microscopic examination of the fingernail bed showed normal capillaries. Roentgenogram of the chest showed the lungs to be normal. The heart was normal in size and shape, but the aorta was widened.

Roentgenograms of the bones showed the following findings: parallel coarse but regular trabeculations; vertical striations characteristic of hemangioma, seen in the bodies of the vertebrae L3 and L4 and increased translucency of the bone (Fig. 3). Areas of rarefaction with fine bony trabeculations, cyst-like in character, are seen in distal part of the right clavicle and upper part of the neck of the right scapula (Fig. 4). An area of rarefaction of honey-combed appearance with coarse trabeculations was seen in the lower part of the neck of the left scapula (Fig. 5). No changes were found in the ribs or in the rest of the spine.

Histopathological examination of the angioma from the skin of the back showed a thin

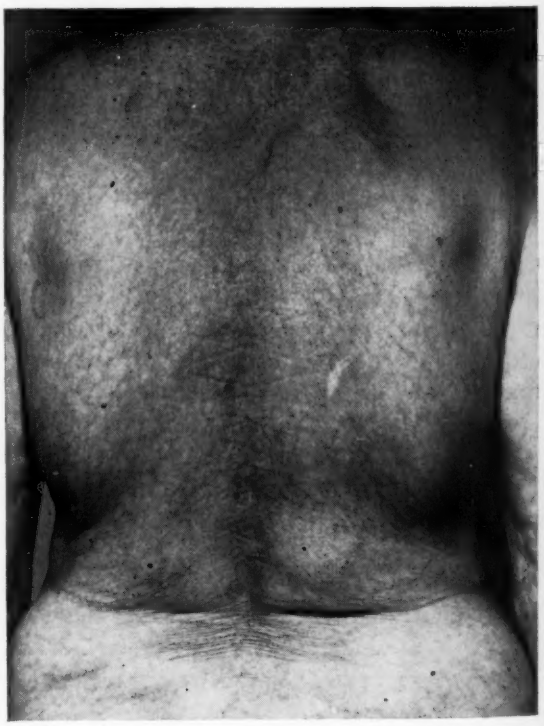

Fig. 2

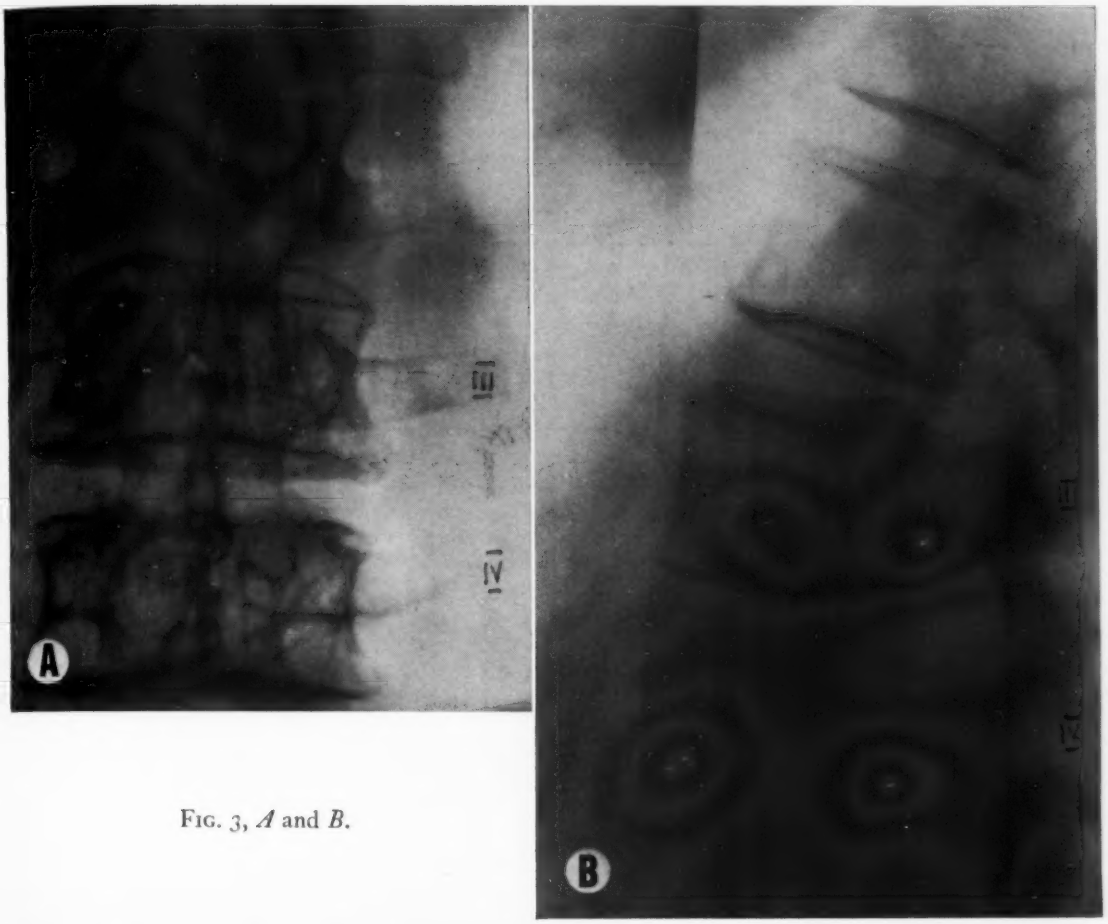

FIG. 3, *A* and *B*.

FIG. 4

FIG. 5

TABLE I

DEEP ROENTGEN THERAPY

Date		Conditions	Region Irradiated	Dose in Roentgens
from	to			
22.12.49	15.1.50	170 kv., 12 ma., 0.5 mm. Cu+1 mm. Al. F.S.D.=40 cm.	Lumbar	2,000
15. 3.51	28.3.51	190 kv., 8 ma., 0.5 mm. Cu+1 mm. Al. F.S.D.=30 cm. 10×15 cm.	Lumbodorsal	750
21. 5.52	6.6.52	190 kv., 8 ma., 0.5 mm. Cu+1 mm. Al. F.S.D.=30 cm. 10×15 cm.	Lumbodorsal	1,200
4. 1.53	29.1.53	190 kv., 8 ma., 0.5 mm. Cu+1 mm. Al. F.S.D.=30 cm. 10×15 cm.	Lumbar-media	1,600
5. 1.53	16.1.53	250 kv., 15 ma., 0.5 mm. Cu+1 mm. Al. F.S.D.=50 cm. 6×8 cm.	Left zygomatic+petrosal	800
			Right zygomatic+petrosal	800
1. 6.53	7.6.53	250 kv., 15 ma., 0.5 mm. Cu+1 mm. Al. F.S.D.=50 cm. 6×8 cm.	Left temporal	750
			Right temporal	600

epidermis composed of three to four layers of cells. The epidermis was atrophic at the site of the underlying pathological lesion. The entire subpapillary layer and the mid-dermis contained many vascular spaces, lined by one layer of endothelial cells and filled with erythrocytes. The size of the vascular spaces ranged in diameter from 25 to 300 μ. Anatomical diagnosis: Capillary hemangioma

During the three years that the patient has been under our observation, the skin angiomas have increased in size and number. Epistaxes have continued at intervals. There have been no changes in the roentgen findings. Because of the complaints of pain it was indicated to treat the bone angiomas with deep roentgen therapy (see Table 1). The pains improved markedly two weeks after the beginning of therapy and finally they disappeared.

Six months ago the patient began to suffer from severe occipital and temporal headaches. A roentgenogram of the skull was negative. Following deep reontgen therapy to these regions, the headaches disappeared. Recently the headaches recurred but disappeared again after another course of irradiation (see Table 1).

SUMMARY

A case of hereditary hemorrhagic telangiectasis is reported in which bone angiomas, confirmed roentgenologically, produced symptoms which responded to deep roentgen therapy. This is apparently the first reported case of this disease with involvement of the bones.

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UNUSUAL FEATURES OF MULTIPLE MYELOMA*

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A ROENTGENOGRAPHIC diagnosis of multiple myeloma is not difficult when the typical, purely osteolytic, "punched-out" lesions are present. This type of lesion is seen predominantly in the skull, although it may be present in other bones of the body. However, its occurrence is far less common than might be expected. Heiser and Schwartzman,[11] in reviewing 62 cases of myeloma, concluded that the "punched out" lesion was exceptional and was found in the skull as the exclusive type of bone lesion in only 13 per cent of the cases. Early in the course of the disease these lesions are confined to the diploe, and tangential views are necessary for roentgenographic detection. Later, the lesions tend to increase in size and number, coalesce and invade both the inner and outer tables. There is no predilection for any one table. Fractures and soft tissue masses are not usual occurrences in the skull. It is this latter appearance of multiple myeloma that will be difficult or impossible to differentiate from other lesions without a biopsy.

Case 1. (No. 674247) Figure 1 is the skull roentgenogram of O.M., a man, aged sixty-nine, who was admitted to the Presbyterian Hospital in May, 1942, because of a lump felt by him in the left frontal area two weeks previously. The soft tissue mass measured 3.5 by 6 cm., was soft, nontender and without redness of the skin. Linear fine ridges were also palpable over the mass and a bone margin was felt all the way around the lump measuring 6 by 9 cm. The films were interpreted "as showing a large area of diminished density in the left side of the frontal bone extending back a short distance into the parietal bone. The outlines of this area are quite well defined. In the center of the involved area both tables have apparently been destroyed. But, around the periphery, one table, apparently the outer, is preserved. In two places strands of bone seem to cross the area where the bone is absent. The margin of this area is well defined. In other places, the impression is gained that the inner table is bulged inward. The appearance is that of an expanding lesion which has destroyed bone by pressure. There is no evidence of atrophy of the sella turcica. The pineal gland is calcified and lies in its normal position. In the posterior part of the right mandible lie two areas of diminished density within the bone which have well defined margins. Films were made of the entire skeleton except for the hands and feet. No evidence of bone destruction in any other area can be made out."

The various possibilities mentioned from these roentgenograms were: (1) a malignant

Fig. 1. Case 1. The large osteolytic defect involving the left frontal bone and extending into the left parietal bone is well defined; it has destroyed both tables in its center while in other areas the impression is gained that the inner table is bulged.

* Presented as an exhibit at the Thirty-eighth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 7–12, 1952.

process probably a myeloma; (2) possibly metastatic malignant disease; (3) epidermoid cyst; (4) xanthoma. A biopsy specimen was taken of the soft tissue tumor which had a definite capsule beneath which the tissue appeared somewhat reddish, vascular and soft, resembling grossly thyroid tissue. Dr. A. P. Stout made a diagnosis of multiple myeloma of the skull.

Following this, the patient received external irradiation through three ports; one measured 7 cm. in diameter, the other two were 6 by 8 cm. A total of 1,400 r (in air) was given to each port in sixteen days. The factors used were: 200 kv., 25 ma., 50 cm., target skin distance and 2 mm. Cu filter. Two months following the beginning of roentgen therapy no soft tissue tumor was palpable. In December, 1943, seventeen months following therapy, roentgenograms disclosed definite evidence of new bone formation over the anterior part of the defect in the frontal and parietal regions. In 1945, widespread osteolytic lesions became apparent in other bones of the body.

Comment. Ferguson[8] states that myeloma does not expand the cortex. However, these lesions were expansile as is found in some other cases. This is particularly true of lesions occurring in the ribs.

Geschickter and Copeland[10] feel that the strands of bone seen in the osteolytic lesions represent thinned cortex not yet completely destroyed.

In the differential diagnosis several factors may be of assistance, but often biopsy is essential. Pugh[17] states that "if lesions are present in the mandible and are as extensive as the skull lesions the more likely diagnosis is multiple myeloma since metastatic carcinoma is not likely to do this." This case did not have extensive mandibular involvement. Osteoporosis circumscripta can appear exactly as the above lesion but does not have an associated soft tissue lesion and its edges are not as distinct. An epidermoid usually is associated with a scalloped dense margin. Eosinphilic granuloma occurs in a much younger age group and is associated with eosinophils and histiocytes in the biopsy. Hydatid disease of bone is rare in this country, and in 50 per cent of the cases it involves the vertebrae and ilium. Malignant giant cell tumor usually has a more distinct soap bubble appearance due to crisscrossed large condensed trabeculae. However, a histopathological diagnosis is usually necessary. Metastatic carcinoma is the most difficult lesion to differentiate. This is particularly true of the large lytic lesion which may occur secondary to thyroid carcinoma and give an appearance exactly like that shown in Figure 1. Unless the primary site is known histopathological diagnosis is essential.

This case also indicates that sclerosis may be expected in some cases following roentgen therapy and that a soft tissue mass may be eradicated as well.

Another unusual feature is the well defined capsule noted at the time of biopsy. Usually, the nodules are not well circumscribed and have no surrounding membrane.

This same patient (Case 1) remained remarkably well until February, 1945, when he was readmitted because of pain in the left clavicle and base of his spine. Two months previously he had fallen on an icy sidewalk and struck his left shoulder. Roentgenograms taken at this time disclosed an extension of the myelomatous destruction to many ribs, left scapula and the right ischium as well as a fracture of the left clavicle. The entire spine was free of involvement. Because of the increasing pain during his hospital stay, external irradiation was given to the left clavicle and to the sacral area. The upper limit of the 15 by 20 sacral port extended to L5.

In March, 1945, films of the skull showed no change in the large defect in the frontal bone but several smaller rounded radiolucencies were noted in the parietal and occipital bones which were not present in the examination of 1943.

A lateral film of the lumbar spine (Fig. 2) disclosed an osteolytic and osteoblastic lesion involving the entire body of L1 with slight compression of the posterior half of the body. Following discharge from the hospital the patient was lost to follow-up.

Comment. Multiple myeloma is a purely destructive disease with few osteoblastic reactions. The myeloma cells form nodules

Fig. 2. Case 1. Roentgenogram taken three years following onset discloses an osteolytic and osteoblastic lesion involving the entire body of L1 with slight compression of the posterior half of the body.

which grow, undergo hemorrhage and cause pressure necrosis and on roentgen examination lytic lesions are the resultant feature. However, Kohler and Laur[13] report a case of an osteoblastic reaction noted within the pelvis of a sixty-five year old female with proven myeloma. All other causes for the sclerosis were ruled out. In addition, they cite 4 other instances of osteosclerosis in 179 cases of plasmocytoma reported in the literature. One of these was a case reported by Bailey[2] of sclerosis following roentgen treatment of a lesion of the humerus. Krainin, D'Angio and Smelin[14] reported a case of new bone formation involving the entire left humerus and upper radius in a patient who had not received radiotherapy or had a pathological fracture. The case presented adds one more case to the literature of the rare occurrence of osteosclerosis associated with myeloma.

Pendergrass[16] believes that, though the nodules are not well circumscribed and have no surrounding membrane, the thin bone shell about them indicates an ability to call forth a moderate bone reaction. When one bears this opinion in mind plus the frequent finding of sclerosis about the margins of a relatively slowly growing metastatic osteolytic lesion, it is surprising that sclerosis in multiple myeloma is so infrequent, particularly in the relatively slow growing, so-called "solitary myelomas."

The following case contains several interesting features.

Case II. (No. 220883) In March, 1934, A.S., a man, aged thirty-two, was admitted to the Neurological Institute with a history of pain in the back of three months' duration, associated with signs of transverse myelitis.

Laboratory and roentgen examinations of the spine added no information.

On April 14, 1934, a complete laminectomy was performed with removal of the spinous processes of T3, T4 and T5. A completely extradural mass was found and removed. The histopathological diagnosis made from sections of this mass was "myeloma."

Two weeks later external irradiation was given to the spine through three fields for a total tissue dose of 3,840 r. The patient made an excellent recovery and was able to return to work as a painter within a year.

In January, 1942, the patient complained of a lump over his sternum which was quite painful, inability to move his left arm and easy fatigability.

In June, 1942, a small nodule about 1.5 cm. in diameter developed over the right frontal region. These nodules continued to grow and films of the sternum (Fig. 3) disclosed a trabeculated, expanding lytic lesion in the manubrium with dislocation of the sternal end of the right clavicle. Numerous radiolucent areas were present in the ribs, particularly the 7th, 8th and 9th on the left, and an apparent old fracture of the right 10th rib. In the skull,

numerous punched out areas were apparent throughout the vault and a large lytic lesion was present in the right frontal bone.

The patient was treated with external irradiation through a 10 by 10 cm. port over the manubrium for a total of 2,150 r (in air) in six weeks. A second field (5 cm. cone) was used over the sternal end of the left clavicle for a total of 2,300 r (in air) in six weeks. Factors used were 200 kv., 25 ma., 50 cm. target skin distance with 0.5 mm. Cu filter. Following this, a total of 1,500 r (in air) was given to the right frontal area. The lesion in the sternum decreased in size and the right frontal mass disappeared. The patient was able to move his left arm again, had no pain, felt well and returned to work.

The patient remained well until August, 1946, except for numbness in his left hand for the past two years and cough with hoarseness of three weeks' duration. Laryngoscopic examination disclosed a subglottic mass which was red and smooth. The hoarseness cleared and the patient was temporarily lost to follow-up.

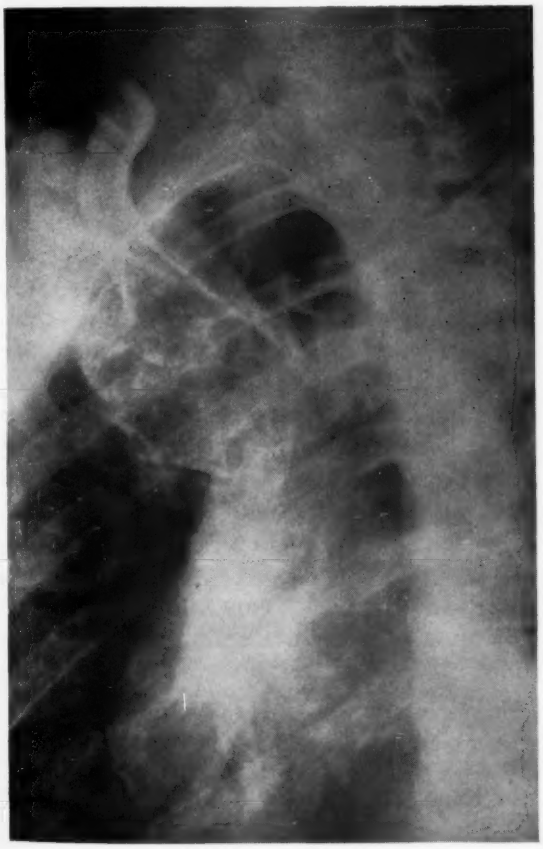

Fig. 3. Case 11. Roentgenogram shows a trabeculated expanding lesion in the manubrium with dislocation of the sternal end of the right clavicle.

Fig. 4. Case 11. The manubrial lesion is larger and contains more calcium than originally. The lesion of the right ninth rib has enlarged and expanded the cortex.

In June, 1950, the patient was readmitted because of a productive cough, marked hoarseness of severe exertional dyspnea. A tracheostomy was performed and biopsies of the mass and a cervical lymph node disclosed squamous metaplasia on histological section of the node and amyloidosis of the larynx with ossification of tracheal cartilage on section of the mass. The sections were negative for cancer; Bence-Jones protein was negative. It was the general consensus that operative procedures were contraindicated.

A skeletal survey disclosed a slow but definite increase of the skull lesions since 1943. Also, the manubrial lesion was larger (Fig. 4) and contained more calcium than originally. The lesion in the ninth rib on the right had enlarged considerably and expanded the rib in the axillary line. The other rib lesions were not changed appreciably. Films of the neck (Fig. 5) disclosed a soft tissue mass bulging into the tracheal air column and situated in the subglottic area. No lesions were present in the spine, pelvis or long bones. The patient was last seen on August 21, 1950, still without complaints, but

Fig. 5. Case 11. This shows the soft tissue subglottic mass bulging into the tracheal air column.

he died suddenly on August 29, 1950, at home. No autopsy was obtained.

Comment. Several features are exceptionally unusual in this case: (1) The average life expectancy in multiple myeloma is approximately two years. Geschickter and Copeland[10] followed one case for seven years. Batts[3] in a study of 40 cases of multiple myeloma out of 300,000 admissions to the University of Michigan Hospital reported a case surviving fourteen years and four months following the onset of symptoms. In his case report, symptoms had started following a fall five years prior to the first diagnosis of multiple myeloma. The case presented in this paper survived sixteen years eight months following the onset of symptoms, or sixteen years and five months following the histopathological diagnosis of myeloma.

(2) d'Alo[7] states that "25 per cent of the cases of 'solitary myeloma' will remain solitary over a period of four years and that 35 per cent will become multiple in two years." Coley[5] reports 2 known cases of solitary myeloma which were alive four to ten years and 6 cases alive seven to ten years. These were removed surgically and followed with irradiation. Garland[9] reports a nine year survival following laminectomy and irradiation. Jacox and Kahn[13] were among the first to report on the importance of irradiation following laminectomy in cases of cord compression. In 1933 they reported 2 cases under their care in which motor function returned following laminectomy and irradiation, and cited 3 other cases from the literature. All these authors agree on the importance of external irradiation following laminectomy in extending life expectancy. The case presented conforms with this idea and also bears out the observation of Jacox and Kahn and of Garland and Kennedy that in cases of transverse myelitis motor function will return. Also, that pain is relieved, the growth of the tumor can be arrested and that recalcification can occur following radiation therapy.

(3) The term "solitary myeloma" is a misleading one. Any case of so-called "solitary myeloma," if followed sufficiently long will eventually become multiple. Death may occur before this multiplicity is apparent roentgenographically, but sternal marrow aspirations will disclose myeloma cells in many cases indicating that the disease is generalized.

(4) The long delayed appearance of multiple lesions (seven years nine months) and the slow progress of these multiple lesions once they occurred (eight years eleven months) is unusual.

(5) Repeated examinations for Bence-Jones proteins were negative throughout the long course of the disease. Statistically 65 per cent of patients with multiple myeloma will show a positive Bence-Jones proteinuria some time during the course of their disease as well as hyperproteinemia.

However, I believe Collier, Reich and King[6] are on the threshold of an important contribution in regard to the chemistry of multiple myeloma. They state that only 16 per cent of patients have a hyperproteinemia due specifically to Bence-Jones protein and not to some other globulin factor. They feel that the Bence-Jones protein has a specific immunological identity which they are able to detect in those cases having a negative chemistry by a "salting out technique."

(6) The long presence of a subglottic mass (four years one month) with the presence of amyloidosis is another interesting feature of Case II. Amyloidosis is said to complicate multiple myeloma in approximately 7 per cent of the cases and may cause death by renal failure. This patient had no renal impairment at any time. Lichtenstein and Jaffe[15] have cautioned that the possibility of myeloma should be investigated in every case of idiopathic amyloidosis even though the bones present no evidence of tumor either roentgenographically or on gross inspection at autopsy.

(7) The lesion in the ninth rib again supports the idea that multiple myeloma can expand bone. In addition, the appearance of this lesion would be difficult to differentiate from giant cell tumor, metastatic carcinoma or hyperparathyroidism.

Case III (No. 536989). W.C., a man, aged fifty, was admitted to Presbyterian Hospital because of pain in the chest initiated by eating for the prior two and a half months, which kept him awake nights. Two or three days before admission he had a severe pain in the upper back which was intensified with motion. In addition, he complained of extreme weakness, weight loss and tenderness over T2–T4.

Laboratory tests were negative for Bence-Jones protein, elevated globulin, plasma cells and anemia.

Roentgenograms of the chest (Fig. 6), spine and esophagus revealed a homogeneous density in the right upper lung field with convexity of its lower border suggesting neoplasm. Films of the dorsal spine, including the ribs, showed no

Fig. 6. Case III. Roentgenogram shows a homogeneous density in the right upper lung field with convexity of its lower border suggesting neoplasm.

involvement of the vertebral bodies. The right third, fourth, and fifth ribs disclosed erosion of the cortices suggesting metastases or direct extension from the lung neoplasm or tumor growth of the pleura.

The day following admission he developed a complete cord compression with inability to void, and paralysis of both legs. The course was steadily retrogressive and the patient died twenty-five days following admission. The clinical diagnosis was carcinoma of the lung (?), multiple myeloma (?).

At autopsy a tumor was found to replace the pleura over the superior, posterior and lateral regions of the lung. The parietal and visceral pleura of the right lung were adherent over all portions. Over the superior portion of the right lung the pleura was tremendously thickened by tumor tissue measuring about 1–1.5 cm. The tumor invaded and replaced the pleura and grew into the interlobar septum between the upper and middle lobes but did not invade the lung. The tumor was also found lying in the intercostal spaces of the first to the seventh ribs but did not invade the musculature. The third to sixth posterior ribs were eroded. The vertebrae were not involved but strands of tumor grew into the spinal canal at the point of

exit of the intercostal nerves to the external surface of the dura which was fibrotic, but did not penetrate the dura. The underlying arachnoid and nerve roots were normal in appearance. Diagnosis: Multiple myeloma of the plasma cell type.

Comment. During life all the characteristic features of myeloma were lacking. There was no hyperproteinemia or change in the A–G ratio. Bence-Jones protein was not found in the urine despite the fact that in terminal cases of multiple myeloma this protein has a constant presence in the urine, whereas in the early course of the disease it may be present only intermittently or not at all. Further, no plasma cells were present in the blood and there was no impairment of kidney function except terminally.

Fig. 7. Case iv. Roentgenogram shows destruction of the bodies of C5, C6 and C7, collapse of C6, lytic lesions extending into the lamina and bony spurs on the anterior surface of the involved segments.

The massive extension of the growth to the pleura is entirely unusual. Commonly, the tumor masses which are present will only displace the pleura when they grow towards it, but seldom invade the pleura or the lung. This case demonstrated actual invasion of the pleura but no invasion of the lung.

Case iv. (No. 942600) B.S., a man, aged sixty-three, was admitted to Presbyterian Hospital with a chief complaint of pain in the neck radiating down both arms of three weeks' duration and ulcerated lesions of the mouth of four weeks' duration. Six weeks before entry the patient developed a "fever blister" around the lips. This cleared in four to five days. A few days later he started to have posterior neck pain with radiation down both arms. Four weeks prior to entry he noted a sore on the lateral aspect of the left side of the tongue and the inside of the left lower lip. This burst while eating, discharging blood. Biopsies of two of the lesions disclosed the presence of Kaposi's fibrosing angioendothelioma. A film of the chest disclosed a well circumscribed soft tissue mass bulging into the right thoracic cavity at the level of the right fifth anterior rib possibly originating from the pleura but with no rib involvement. Roentgenograms of the cervical spine (Fig. 7) disclosed "gross destruction of the bodies of the fifth, sixth, and seventh cervical vertebrae. The body of C6 is collapsed to one-half its normal height. Bony spurs are present along the anterior surface of the involved segments. Lytic changes into the lamina on the left also are present. In view of the chest lesion, the changes in the cervical spine could be due to metastatic malignancy, *e.g.*, myeloma or mesothelioma of the pleura. Tuberculosis cannot be excluded. However, the process in the cervical spine resembles a chronic osteomyelitis more than any other condition mentioned. The possibility of actinomycosis is also suggested."

A skeletal survey added no further information except for punched out areas on the medial aspect of the distal end of the radius on the right and punched out areas in the carpal bones bilaterally associated with capsular distention and preservation of the joint spaces. The radiologist suggested that "a bilateral hemarthrosis, probably associated with the clinical impression of Kaposi's disease, should be seriously considered."

Laboratory studies disclosed a hemoglobin of 10 grams, red blood count 3.9 millions and erythrocyte sedimentation rate 37 mm. per hour; urine 1.012 (max.) alb.+++, Bence-Jones protein present on two occasions; urea nitrogen 39. Sternal and ileal marrow negative for myeloma or tumor cells.

Course. The patient remained afebrile but his course continued steadily retrogressive. His severe pain was treated with neck traction and, with the thought that he had a Kaposi's sarcoma, he was given irradiation to the neck with questionable relief. He developed urinary retention presumably on a basis of benign prostatic hypertrophy and required catheterization. Pain was not relieved with opiates. Terminally he developed a bronchopneumonia and thrombophlebitis and died four months following admission.

Autopsy. The mass in the right thorax originated from the fifth rib and extended into the pleural cavity but without invasion of the pleura and was composed of plasma cells. The sixth cervical vertebra was highly sclerosed and completely ankylosed to the fifth and seventh vertebrae. The postirradiation sclerosis and fibrosis had partially obliterated the plasma cells.

Comment. This case illustrates the existence of two unrelated lesions, each relatively rare, in the same patient, *viz.*, Kaposi's disease and multiple myeloma. The former was incidental to the widespread plasma cell myeloma which had caused collapse of the sixth cervical vertebra.

When myeloma involves the spine, the lower thoracic and upper lumbar areas are the sites of predilection. Vertebral collapse is associated in approximately 73 per cent of the cases and the vertebrae involved tend to be multiple. It is rare for involvement to be contiguous and still rarer for extension across the disc space. Heiser and Schwartzman[11] have reported 2 cases of extension across the disc space. No instance of ankylosis of adjacent vertebral bodies have been reported to my knowledge.

Case v. (No. 002241). Another illustration of vertebral involvement is the case of W.D., a man, aged forty-one, who was admitted to the Presbyterian Hospital because of severe inter-

Fig. 8. Case v. Roentgenogram taken thirteen months following onset shows extension of the osteolytic lesions to involve T5 and T7 with narrowing of the discs, collapse of T6, destruction of the right sixth rib and a paravertebral mass.

scapular pain of seven weeks' duration. In addition, he had cord compression as evidenced by bladder and bowel impairment and numbness extending from the lower abdomen to the feet. A roentgenogram of the chest disclosed an osteolytic lesion of T6. No other lesions were present in the other bones of the body. A laminectomy was performed from T_4 to T8 with removal of an epidural mass which was histopathologically diagnosed as myeloma. The patient was then treated with urethane.

Approximately thirteen months later, a roentgenogram of the spine (Fig. 8) disclosed extension of the osteolytic lesion to involve T5 and T7 with narrowing of the discs, collapse of T6, destruction of the right sixth rib and a paravertebral mass.

Comment. This case again illustrates the commonly observed collapse when vertebral bodies are involved associated with the rare occurrence of extension across the disc

FIG. 9

FIG. 10

FIG. 9 and 10. Case VI. Roentgenograms disclose areas of diminished density in the lower third of both tibias and fibulas. The talus and calcaneus are extensively destroyed on the right with a soft tissue mass present. Spotty areas of destruction in the left os calcis are noted.

space. In addition, the presence of a soft tissue mass must be distinguished from tuberculosis and lymphoma. Occasionally a metastatic lesion may give a soft tissue mass as actinomycosis can.

Case vi. (893366). This man, A.K., aged fifty-four, was admitted to Presbyterian Hospital because of migratory polyarthritis of six months' duration consisting of pain and slight swelling involving the ankles, knees and elbows. Just prior to admission the right ankle became continuously painful and he was unable to walk without a cane. In addition, he had lost 25 pounds. A local physician had treated him with penicillin, colchicine, low purine diet and neocincophen without benefit. An osteopath had manipulated his right ankle three times causing extreme pain each time. His right testicle had always been larger than the left but had increased even more in size during his present illness and contained a hard mass.

Bence-Jones protein was absent. Uric acid was normal; red blood cell count 5.3 million, hemoglobin 16 gm.

Roentgenograms disclosed areas of diminished density in the upper middle and lower thirds of the right tibia and a diminished density in the lower third of the right fibula. The right talus and calcaneus (Fig. 9 and 10) were extensively destroyed. Diminished densities in the distal end of the left tibia and spotty areas of demineralization and possibly destruction in the left os calcis also were noted. Other bones were negative for similar lesions.

A biopsy of the lesion of the right os calcis which also had a soft tissue mass was taken and proved to be a myeloma, not of the plasma cell type. The right testicle was removed and was reported by the pathologist as secondary myeloma similar in appearance to that found in the section of the os calcis. The patient also had a hydrocele of the cord.

Comment. The bone lesions in this case were extremely unusual in their locations; particularly in the involvement of the os calcis bilaterally. This caused considerable confusion prior to biopsy and various possibilities were mentioned in the differential diagnosis, *viz.*, osteomyelitis, metastatic carcinoma from the testicle, which is unusual in the tibia, fibula and tarsal bones, Ewings tumor and lipoidosis. The involvement of the testicle with multiple myeloma secondarily is also an extremely unusual extramedullary site, although it has been seen in one other instance at this hospital.

SUMMARY

The many unusual features demonstrated in these six cases of multiple myeloma confirm the opinions of Camp, Batts, Lichtenstein and Jaffe, and others, that multiple myeloma has no characteristic roentgenographic features that will result in its definite diagnosis. The "punched out" lesion primarily held to be characteristic is seen to be present in a minority of the cases. Biopsy and autopsy specimens are essential in many cases to reach a final definite diagnosis.

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EARLY ROENTGEN DIAGNOSIS OF SPASTIC CONTRACTION RING IN THE UTERUS (BANDL'S RING) DURING LABOR AND ROENTGENOGRAPHIC DEMONSTRATION OF THE SUBCUTANEOUS FAT DEPOSITS OF THE FETUS ("THE FAT LINE") AND OF THE PLACENTA

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Dystocie par l'anneau de Bandl, stricture de l'anneau de contraction, est une complication de l'accouchement, fort digne de tirer l'attention. Car c'est une complication presque surement mortelle au foetus et qui peut amener pour la mère les plus grands dangers, si elle n'est pas reconnue a temps et bien soignèe.

LEOPOLD MEYER

THIS was confirmed in a study by Gammeltoft in 1918. He subjected a series of 23 cases of dystocia due to Bandl's ring from the Maternal Hospital in Copenhagen to a close analysis and found that in 20 of these cases a dead fetus was born after severe intrauterine obstetric procedures, and that rupture of the uterus occurred in 3 cases, 2 of which terminated fatally.

The difficulties in diagnosing a contraction ring as an obstruction to delivery are great and well known. By palpation and ordinary vaginal examination, it is usually impossible to establish the diagnosis because a large fetal part (head or breech) is forelying and situated distal to the contraction ring. As a rule, the diagnosis can be made only by intrauterine manipulations indicated by protracted, painful and nonprogressive labor and by the condition of the mother and child. Most frequently, there will be absolute indications for the termination of labor by forceps delivery after perforation, basiotripsy or the even more drastic embryotomy, because it is too late to employ conservative measures with injection of large doses of morphine.

It would be of great importance if we were able to make the diagnosis at an earlier stage than has generally been possible so far and then institute a treatment which would shorten the painful condition of the parturient and diminish the danger of the life of the fetus, at the same time avoiding the exposure of the mother to the hazards of one or more vaginal examinations and difficult and dangerous obstetric procedures.

A series of 15 parturient patients with obstructed delivery due to contraction of Bandl's ring, who were treated in the Central Hospital, Randers, during 1944–1947, has been subjected to a closer study.

In 10 of these patients roentgenograms were taken with a view to the possibility of diagnosing a spastic contraction ring and disclosing a pathologic position of the presenting part and its location in the birth canal.

In all 15 cases inquiries were made to ascertain (1) when the liquor amnii escaped, (2) to what extent oxytocics had been employed, and (3) if amyl nitrite inhalations had been capable of relaxing the spastic contracting ring in the uterus during labor.

The 15 cases may be divided into two groups. The first group comprised 8 patients, of whom only 3 were subjected to roentgen examination. These 3 patients did

not gain any benefit from the roentgen examination, since at that time we were unaware of the possibility of demonstrating spastic contraction of Bandl's ring roentgenographically. After the delivery a study of the roentgenograms from these 3 patients revealed the following findings:

Case I. *Roentgen Examination.* There was no disproportion between the size of the fetus and the aperture of the pelvic inlet. As the fetal head was partly rotated but flexed (in deflexion attitude), it was diagnosed as a case of brow presentation. The frontal part was directed downward to the right and the occipital part upward to the left. The fetal and maternal spines ran parallel, the former to the right of the latter; small parts both on the right and left. In the lateral view the fetal head was seen above the pelvic inlet with the occipital part directed forward and upward. The spine showed a marked curvature and was located backward in relation to the other fetal parts. *The posterior wall of the uterus was seen as a well-defined soft part shadow increasing in width distally, at the junction of the fetal head and trunk forming a triangle, the apex of which pointed to the fetal neck.* Ventralward, the uterus was seen as a soft part shadow, 1 cm. in width, which was not so well defined as the dorsal uterine shadow. At the level of the neck the uterine musculature curved toward the fetus. In this curve formed by the uterine musculature a fainter shadow of the abdominal wall was seen. The massive homogeneous triangle dorsally and the curve ventralward in the roentgenogram must be assumed to indicate the severe spastic contraction of Bandl's ring seen during labor (Fig. 1).

Case II. *Roentgen Examination.* Cephalic presentation with back to the right. Head a little to the right. In the lateral view the fetal spine was seen dorsally, the head in deflexion attitude with the cervical part of the spine curving forward. Dorsally, a triangular muscle shadow was seen between the fetal head and trunk. Dorsoproximally in the uterus, a large soft part shadow indicating the site of the placenta was observed. A band of lessened density produced by the subcutaneous fat deposits of the fetus—"the fat line"—was seen betweeen the fetus and the placenta (Fig. 2).

Case III. *Roentgen Examination.* Deflexion attitude. Head above aperture of pelvic inlet. An extremity along the fetal head. The head dislocated to the right. A triangular shadow of the uterus—most distinct ventralward—was seen between the fetal trunk and head, the apex pointing to the fetal neck (Figs. 3 and 4).

Following severe obstetric procedures the results of delivery in these 8 cases were: dead child in 7 instances and living child in one. In 2 cases the spastic contraction ring persisted in spite of amyl nitrite inhalations under ether anesthesia, while it was relaxed in 6 instances, so that version could be performed. The roentgenographic diagnosis of spastic contraction ring was made by a study of the films after the delivery in 3 cases.

In the following section a second group of 7 additional cases is considered, in which the diagnosis of spastic contraction ring of the uterus was made at the roentgen examination immediately on admission to the hospital. In these 7 cases the diagnosis was made early, i.e., at least before the performance of any obstetric intervention, so that preventive therapy could be instituted.

In 6 of these cases (abnormal cephalic presentation) the spastic contraction ring was found in the distal part of the uterus in the location where Bandl's ring is reported to have its seat. In these 6 cases the spastic contraction ring was relaxed by amyl nitrite inhalations under ether anesthesia, and living infants were born. In the seventh case (complete breech presentation) the spastic contraction ring was seen in the proximal part of the uterus and the infant was dead. Many injections of oxytocics had been given in this case, and the roentgenographic finding was a distinct spastic contraction ring embracing the fetal neck and thorax, which were deformed and compressed. After three hours' treatment with morphine this patient was delivered spontaneously of an asphyxiated child, who could not be resuscitated. It must be assumed that the vigorous circular contraction around its neck and thorax had had a fatal effect on the fetus (cerebral asphyxia, heart failure?).

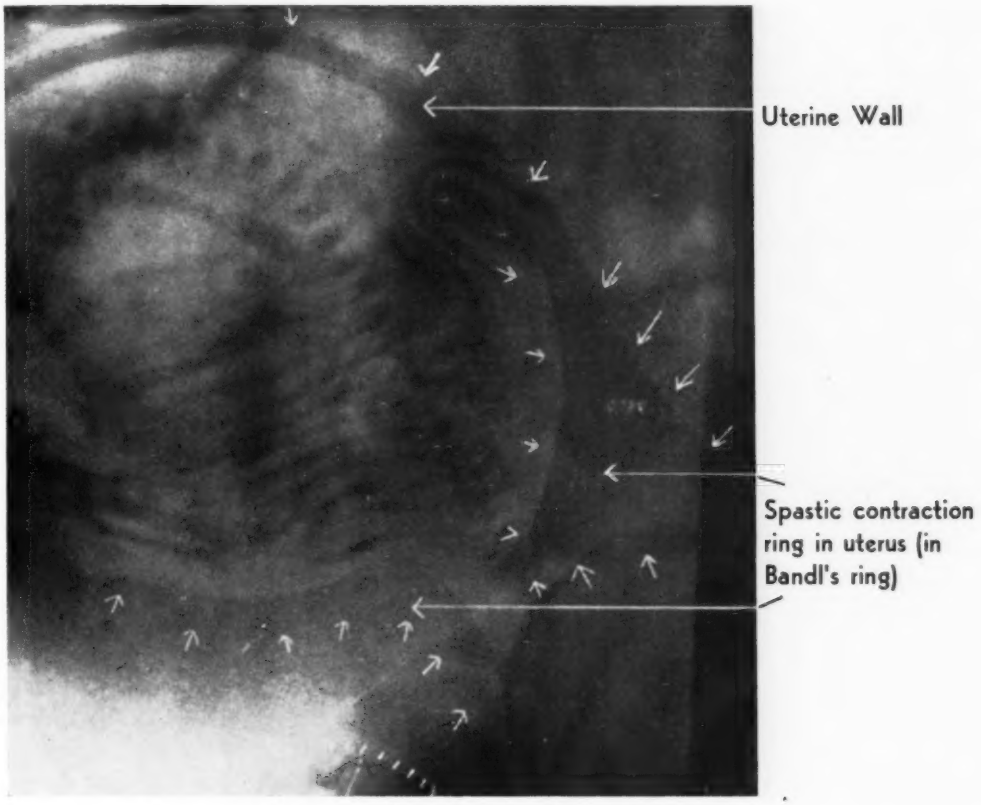


Fig. 1

In summarizing the experience gained in the 15 cases under consideration it may be stated:

(1) That in all 15 patients the liquor amnii had escaped early.

(2) That at least 10 of the 15 patients had been given injections of oxytocics (often many) before the spastic contraction ring in the uterine musculature was diagnosed, but these injections never accelerated delivery in spite of strong and prolonged uterine action. This therapy thus seems to have been ineffective. It cannot be excluded, or rather it must probably be assumed, that it was instrumental in the production and development of the spastic contraction ring, *i.e.*, it had a harmful effect. Nor did the use of oxytocics during the period of expulsion after version increase the prospect of living child in these patients; if anything, rather the contrary.

(3) That amyl nitrite inhalations under ether anesthesia relaxed the spastic contraction ring in 10 of the 12 cases in which this remedy was used. It was only in the 2 severest cases of the series (the longest duration of the spastic contraction ring, use of oxytocics, strong uterine action) that amyl nitrite inhalations proved to be ineffective.

(4) That is was shown by the roentgen examination (later confirmed clinically) that irregular—abnormal—presentation of the forelying part with or without simultaneous forelying extremity was present in all 10 cases, *viz.*, head slipped aside plus forelying hand, 4 cases; breech presentation plus forelying foot, 1 case; brow presentation, 2 cases; face presentation, 1 case; head slipped aside plus deflexion, 2 cases. In the 5 cases where no roentgen examination was made, the clinical findings were: bregmatic presentation, 1 case; deflexion attitude, 1 case; uncertain appraisement of presentation with transverse-standing sagittal suture, 3 cases. (In 2 cases the forceps

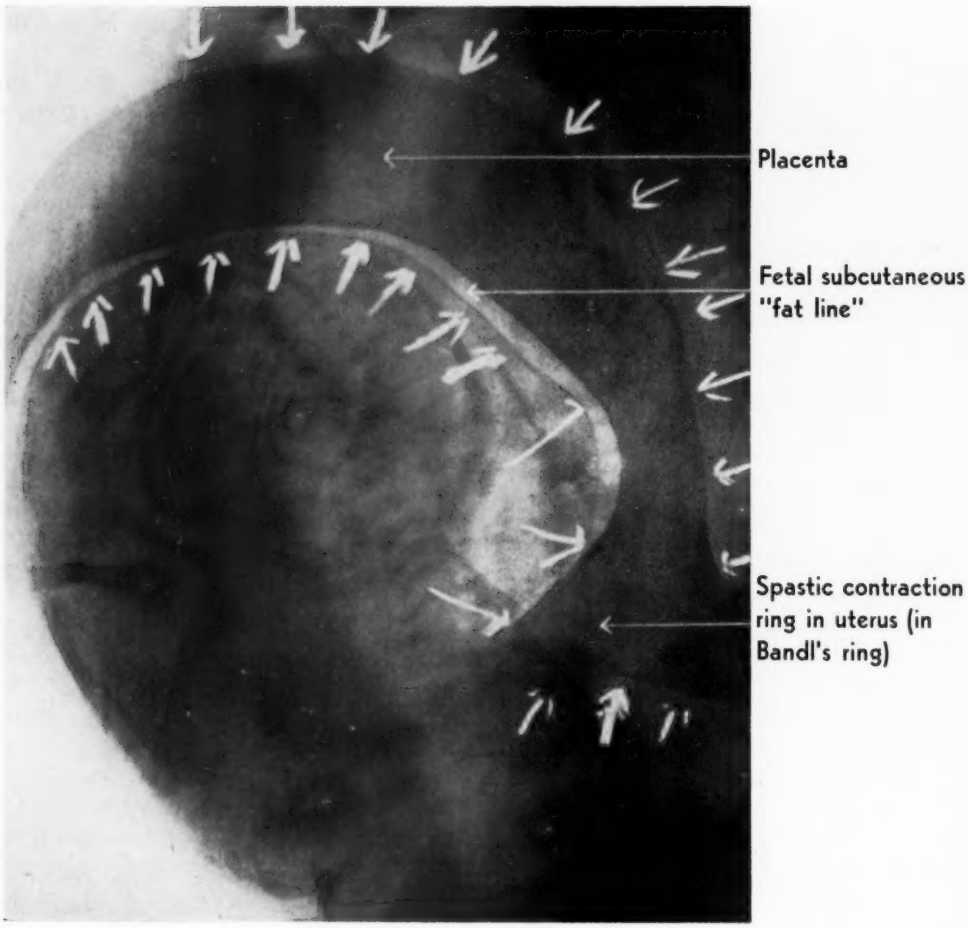


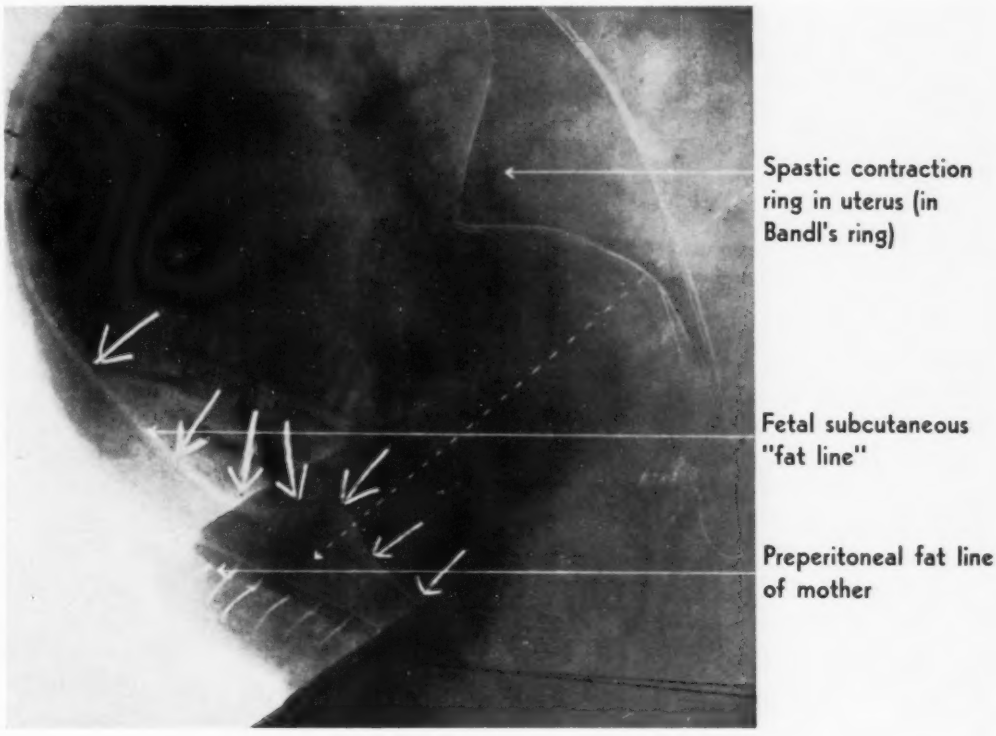
Fig. 2

slipped several times, and in 1 case the forceps could not be applied.) An analysis of Gammeltoft's 21 case reports of unduly protracted labor shows that the abnormal presentation was specified in 10 cases (bregmatic, brow, face, cephalic presentation plus forelying hand and breech presentation plus forelying foot), while unspecified abnormal presentation was stated in 11 cases owing to uncertain findings at the vaginal examination. The observations from Gammeltoft's series lend support to the assumption that abnormal presentation of the forelying part is always present in cases in which spastic contraction ring in the uterus develops during protracted labor with early escape of the liquor amnii.

(5) That in the 10 patients where roentgen examination both in the anteroposterior and lateral planes was made, the lateral view showed a massive, well defined, homogeneous triangular soft part shadow, the acute apex of which pointed to the fetal neck (and thorax), which strongly suggested the presence of a spastic contraction ring in the distal part of the uterus in cephalic presentation (most frequent) or in the proximal part in breech presentation (far less frequent).

Etiology of Spastic Contraction Ring in the Uterus

In general, several layers of muscle fibers may be distinguished in the uterus. The most superficial layer consists of longitudinal fibers, while the direction of



[[Fig. 3

Fig. 4

the fibers of the next layer is more irregular. The third layer is by far the thickest; its muscle bundles interlace and cross to the opposite side, in this way forming rings. The large blood vessels are found in this layer. The fourth submucous layer is composed partly of longitudinal and partly of circular fibers around the tubal ostia and the internal os.

The relative preponderance of the interlacing and crossing muscle bundles of the third layer and the fact that spastic contraction in this region has occasionally been observed as an obstruction to delivery have presumably given rise to the assumption that a sphincter-like musculature should exist in this locality (since 1876 termed Bandl's ring and since 1885 also Schröder's ring). However, there is no distinguishable sphincteric muscle, which may correspond to the massive spastic contraction ring, which sometimes obstructs delivery.

During pregnancy a rapid increase in the

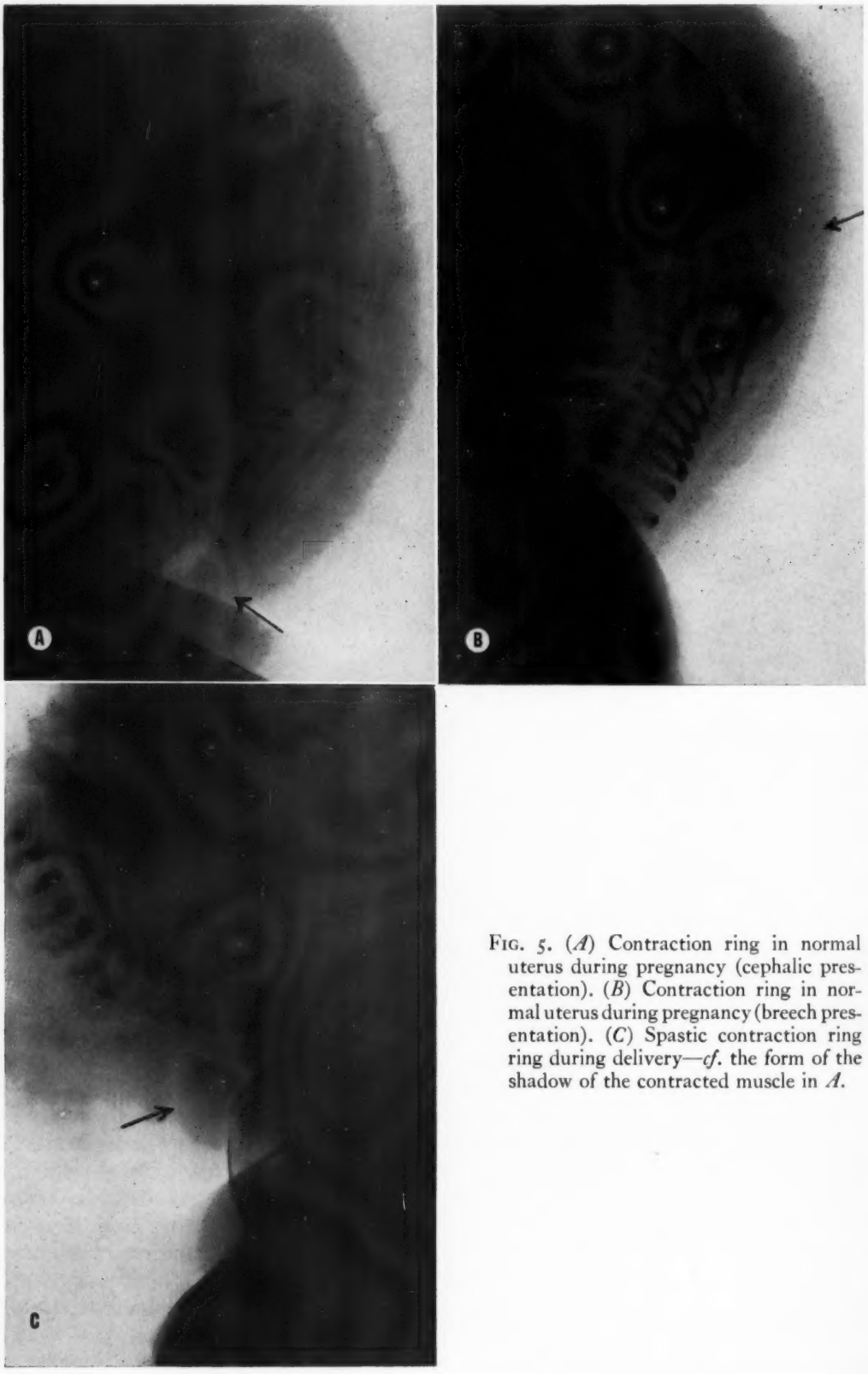


Fig. 5. (*A*) Contraction ring in normal uterus during pregnancy (cephalic presentation). (*B*) Contraction ring in normal uterus during pregnancy (breech presentation). (*C*) Spastic contraction ring ring during delivery—*cf.* the form of the shadow of the contracted muscle in *A*.

size and strength of the uterine musculature occurs, especially in the third layer with the interlacing and crossing muscle bundles. If it be assumed that a uniform, constant tone is present in all parts of the uterine musculature, a circular constriction of the uterine cavity will develop where the surface of the fetus offers least resistance, owing to the relatively greater contraction of the muscle fibers in such a region. As a consequence of this contraction, a certain shift and redistribution of the interlacing and crossing muscle bundles occur, resulting in a relative increase in the uterine muscular mass in the locality which forms the seat of the contraction ring. Between the head and neck of the fetus the mass is less bulky and thus gives favorable conditions for the development of a contraction ring toward the end of the pregnancy.

At roentgen examinations made at this stage of the pregnancy (to determine the position of the fetus, the presence of twins, etc.) the lateral view shows more or less distinctly a triangular, wedge-shaped shadow (with a blunt apex) of the uterine musculature, the location of which corresponds to Bandl's ring. The triangular shadow is demarcated against the fetus by a band of lessened density, the subcutaneous fat deposits of the fetus—"the fat line" (Fig. 5*A*).

In case of breech presentation a triangular wedge-shaped increase in the shadow of the uterine musculature may be observed in the proximal part of the uterus at the level of the neck and thorax of the fetus (Fig. 5*B*).

The triangular shadow indicates a contraction ring in the normal pregnant uterus. It is not an expression of contraction in an anatomically demonstrable sphincter muscle, but of a physiologic condition in the normal pregnant uterus due partly to the manner in which the various muscular layers of the uterus are arranged and partly to irregularities on the surface of the fetus. *The so-called Bandl's ring must therefore be interpreted not as an anatomic phenomenon, but as a physiologic condition depending on function.*

When labor begins, contraction of the entire uterine musculature will increase the intrauterine pressure and thereby cause *partly* an accommodation of the fetus as a preparation for its passage through the birth canal by smoothing out irregularities on its surface (flexion of the head, adaptation of the extremities as related to the trunk, etc.) and *partly* an incipient descent of the forelying part into the birth canal. The contraction ring, which roentgenographically appears as a triangular shadow, will then be absorbed by the rest of the musculature. By roentgen examination of a large number of parturients during labor (most frequently after the discharge of the liquor amnii), in whom the birth subsequently pursued a normal course, I have never been able in the lateral view to disclose any triangular shadow of the uterine musculature corresponding to the location of Bandl's ring, which is in good agreement with the theory advanced above.

If, on the other hand, the forelying part is in an abnormal position, an unfavorable mechanism of labor may develop and if, in such cases, the liquor amnii escapes while the forelying part is high standing, the accommodation of the fetus and its incipient descent will be arrested. A strong uterine action is then excited, and the abnormal position of the forelying part will result in irregularities on the surface of the fetus with portions which offer relatively little resistance to the pressure exerted by the uterine musculature (*i.e.*, the cervical portion in abnormal cephalic presentation, the thoracic portion in irregular breech presentation and the space between twins in unfavorable presentation). In these localities a contraction ring will gradually develop. The contractions of the entire uterus will increase in strength in an attempt at accelerating delivery, with the result that the contraction ring becomes more and more manifest. In this way a dysregulation of the uterine

action arises. If the unfavorable mechanism of labor is not overcome, the dysregulation will persist, and the increasing uterine action will result in protracted muscular contractions, which will ultimately become continuous and of a spastic nature (possibly because of gradual development of ischemia due to the constant contraction of the highly vascular third layer of the uterus).

When the spastic contraction ring has become manifest, forming a direct obstruction to delivery, the uterine action in the corpus will continue with increasing intensity until a spastic muscular contraction occurs also here and gives rise to tetanus uteri.

If oxytocics are administered in such cases, this development will be accelerated by intensifying the action of the entire uterine musculature, so that the spastic contraction ring will become manifest at an earlier stage. Administration of oxytocics must also be assumed to be able to bring about dysregulation and spastic contraction ring in cases where labor allowed to pursue a natural course would have been able to overcome a certain unfavorable mechanism of labor and result in spontaneous delivery. Thus, oxytocics must be presumed to be the direct cause of the development of spastic contraction ring in such cases.

SUMMARY

In all the 15 cases under consideration, in which spastic contraction of the uterus formed an obstruction to delivery, it was possible to demonstrate (1) early escape of the liquor amnii (forelying part high standing) and (2) unfavorable mechanism of labor due to abnormal position of forelying part. These two conditions seem to give rise to a dysregulation of the uterine muscular action which in unduly protracted labor or on administration of oxytocics may develop into a spastic contraction ring and ultimately, together with spastic contraction of the entire uterus, into tetanus uteri.

Spastic contraction ring may be demonstrated roentgenographically.

On suspicion of dysregulation of the uterine action a roentgen examination at an early stage during labor may provide the diagnosis, so that proper obstetric procedures can be taken to shorten the painful condition of the mother and increase the the prospects of survival of the child.

On the roentgenograms the subcutaneous fat deposits of the fetus will provide a distinct demarcation of its shadow as related to that of the uterus and its contents.

The placenta may often be localized in ordinary roentgenograms, notably in the lateral views.

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DEPTH DISTRIBUTION OF IONIZATION FROM A BETATRON BEAM

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IT HAS been demonstrated that the spatial distribution of the ionization produced by medium energy gamma rays is not attenuated in the same manner as the gamma rays themselves. The gamma radiation is diffused through a medium approximately according to an exponential curve. The associated ionization, on the other hand, starts at a near zero value at the surface of the medium, builds up to a maximum, and then decays in a manner similar to the gamma rays. This behavior corresponds roughly to a difference of exponentials.[6]

The radiological importance of this behavior is at once evident, for it is the ionization produced by incident gamma rays that gauges the biological damage suffered by an organism. This problem has been solved in complete detail by one of the present authors.[2] Water, which can be considered a fairly adequate phantom, was used as the diffusion medium. As the source of radiation we used the bremsstrahlung produced by a 40 mev. betatron beam. The solution of this problem was, unfortunately, cumbersome and unwieldy. Since it was an exploratory calculation with a class of different problems in mind, many refinements were included which are unessential for the particular case under consideration. For the latter, various simplifications in the exact solution can be utilized to eliminate several weeks' calculations. Below we shall illustrate the validity of various simplifications and compare the results with those obtained from the complete solution, and with the experimental data. The simplified solution should not be expected to consume more than two or three days of calculation and its accuracy has been found to be within experimental error.

GAMMA-RAY DIFFUSION

We first examine the spectrum of the bremsstrahlung roentgen rays emerging from the betatron. The equation for the diffusion of the radiation through the medium is given by

$$\cos\psi\,\frac{\partial N(z,\lambda,\cos\psi)}{\partial z}+\mu(\lambda)N(z,\lambda,\cos\psi)=\int_{\lambda_0}^{\lambda}d\lambda' K(\lambda',\lambda)\int\frac{d\Omega'}{2\pi}\delta(1-\lambda+\lambda'+\cos\Theta)N(z,\lambda'\cos\psi')+\sum(\lambda_0,\lambda)\delta(z)\delta(1-\cos\psi)$$

where $N(z,\lambda,\cos\psi)$ is the number of photons in the space interval $(z, z+dz)$, the direction interval $[\cos\psi, \cos\psi+d(\cos\psi)]$ and the wavelength interval $(\lambda, \lambda+d\lambda)$; $K(\lambda,\lambda')$ is the Klein-Nishina cross-section[4] and Θ is the scattering angle. In the diffusion equation, equilibrium is assumed: energy loss equals energy gain. The first term on the left-hand side of the equation represents the energy loss due to diffusion. The next term, with $\mu(\lambda)$ the linear absorption coefficient, is the energy lost by absorption. The integral on the right-hand side represents photons Compton-scattered-in from higher energies into the range $(\lambda, \lambda+d\lambda)$. The last term is the source contribution. In the complete solution the 40 mev. source spectrum striking the diffusion medium (water) has been assumed to be that of Schiff.[9] We see from Figure 1 that the Schiff energy spectrum varies with the wavelength, but not very strongly.

Past experience suggests that a polynomial expansion be used to solve the gamma-ray transport equation.[10] This expansion technique involves, initially, de-

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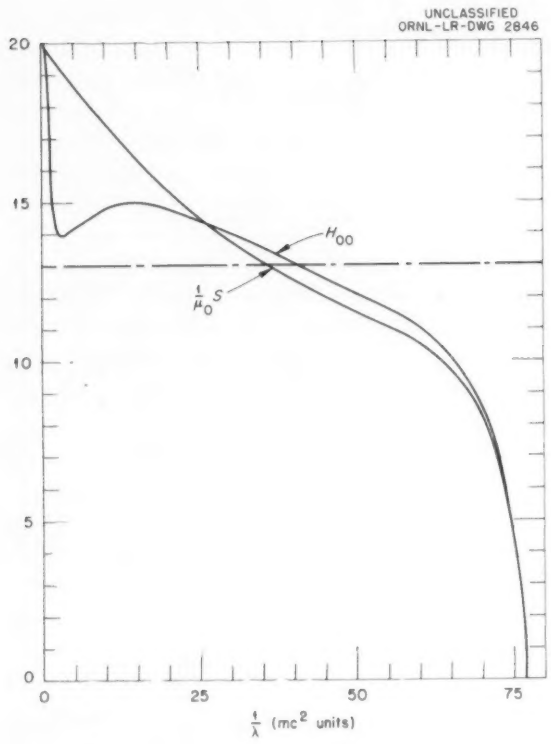

FIG. 1. A plot of the various source terms versus the energy. The energy content under each curve has been normalized to 1,000.

termining a weight function, that is, a function whose behavior generally approximates the correct solution. For the distribution of the gamma rays in depth, it is known that $e_0{}^{-\mu_0 z}$, where μ_0 is the absorption coefficient of the most penetrating component of the radiation, is an excellent weight function. We therefore expand the distribution in terms of the Laguerre polynomials $L_n(\mu_0 z)$, which are orthonormal with respect to this weight function, *i.e.*,

$$\mu_0 \int_0^\infty e^{-\mu_0 z} L_n(\mu_0 z) L_m(\mu_0 z) dz = \delta_{nm}.$$

For the directional distribution, we use the orthonormal set of Legendre polynomials $P_l(\cos\psi)$. We then have reduced the transport equation to an equation between Laguerre-Legendre coefficients N_{ln} which are functions of the wavelength only. Figure 1 shows the wavelength (or energy) dependence of $H_{00}=\lambda N_{00}$ which is seen to be fairly insensitive.

The source term in the diffusion problem for the ionizing electrons has Laguerre-Legendre coefficients $\int_E^\infty G_{ln}(E)dE$ (as discussed below), where

$$G_{ln} = \int d\lambda N_{ln}(\lambda)\sigma(\lambda, E)$$

and $\sigma(\lambda, E)$ is the gamma-to-electron cross-section, the sum of the pair-production and Compton cross-sections. The gamma-ray problem enters only through the N in the integrand of G_{ln}. We now examine, from this point of view, the accuracy needed in evaluating the N_{ln}. Note that we integrate a continuous gamma-ray distribution over a continuous cross-section, and errors are smeared out in the integration. This permits us to resort to considerable approximation for N_{ln} without upsetting the correctness of the solution.

The expansion of the gamma-ray distribution in Laguerre coefficients took into account the fact that an exponential did not quite reproduce the radiation decay. However, in the region we are considering, up to 15 centimeters in the medium, the high energy photons pass through but a fraction of their mean free path. This means that there is not much time for a build-up of ionization and the exponential is sufficiently accurate. Low energy photons do not contribute as much to the energy dissipation, so that the error introduced for them is permissible. This simplification leads one to set $G_{ln}=0$ for $n\neq 0$, in calculating the polynomials.

We now examine the Legendre expansion more closely. Gamma rays that lose little energy in Compton scattering proceed straight ahead. Pair electrons are created in the forward direction, within a cone of angle $1/E$ (in mc² units). The most energetic Compton electrons are also propelled forward. Hence we can consider the electrons to be produced straight ahead. Since

$$\int_{-1}^{1} \delta(1-\cos\psi)P_l(\cos\psi)d(\cos\psi) = P_l(1) = 1,$$

this means setting $G_{l0}=G_{00}$.

Since we have seen that H_{00} does not vary too much over the energy spectrum and further that we do not need to know its value with any great precision, we can hold H_{00} constant over the energy spectrum (see Fig. 1). We then obtain

$$G_{00}(E)=H_{00}\int\sigma_0(\lambda, E)\frac{d\lambda}{\lambda}$$

with H_{00} outside the integral, and integrate to get the electron source term $\int_E^\infty G_{00}(E)dE$. This result is depicted in Figure 2 where, for comparison, we have included the value of $\int_E^\infty G_{00}(E)dE$ obtained from the exact expression. We see that the agreement is very good with the exception of the low energy part, where our findings are too high. This latter disagreement is not unexpected since by assigning a constant value to our bremsstrahlung spectrum we assume that a greater proportion of the energy goes to low energy gamma rays than is correct.

With H_{00} held constant, the integrals for $G_{00}(E)$ and $\int_E^\infty G_{00}(E)dE$ can be carried out analytically with adequate approximation. This means that it is possible to give one algebraic expression for $\int_E^\infty G_{00}(E)dE$ rather than having to carry out two numerical integrations for each energy. These integrals are given in Appendix A.

We have thus found it possible to calculate the electron diffusion source without resorting to the solution of the gamma ray diffusion problem (since we can take H_{00} constant). This saves the labor of computing the Schiff spectrum and solving the gamma-ray transport equation, previously the major portion of the effort associated with the problem.

ELECTRON DIFFUSION

An electron diffusion equation, analogous to the gamma diffusion equation, is given by Lewis.[7] For the one-dimensional case with azimuthal directional symmetry, the Lewis equation becomes, with $\mu=\cos\theta$

$$-\frac{\partial f(\varepsilon,\mu,r)}{\partial r}+\mu\frac{\partial f(\varepsilon,\mu,r)}{\partial\varepsilon}$$

$$=N\int d\Omega'\{[f(\varepsilon,\mu',r)-f(\varepsilon,\mu,r)]\sigma(r\cos\Theta)\}+\Gamma(\varepsilon,\mu,r)$$

where f is the electron flux, σ the cross-section, Γ the explicit source term, and r is the residual range assuming continuous energy loss. We now expand in Legendre-Laguerre coefficients to eliminate the dependence on μ and ε. Additional mathematical manipulation yields the final expression

$$f_{ln}(r)=F_{ln}(E)\frac{dE}{dr}$$

$$=-\frac{\mu_0}{2l+1}\sum_{m=0}^{n-1}\left[(l+1)\int_E^\infty F_{l+1,m}(E)dE+l\int_E^\infty F_{l-1,m}(E)dE\right]-\int_E^\infty k_l(E)F_{ln}(E)dE+\int_E^\infty G_{ln}(E)dE$$

where $k_l(E)=K_l(r)=2\pi N[\sigma_0(r)-\sigma_l(r)]$ and $\int_E^\infty G_{ln}(E)dE$ is the source term which was alluded to in the previous section.

We now see that the energy dissipation, I, has coefficients I_{ln},

$$I_{ln}=\int f_{ln}\left(\frac{dE}{dr}\right)dr=\int f_{ln}(r)dE=\int F_{ln}(E)\left(\frac{dE}{dr}\right)dE.$$

We want to find the energy dissipation as a function of ε regardless of orientation, *i.e.*

$$I_0(y)=\int_{-1}^{1}I(\mu,\varepsilon)d\mu=\mu_0e^{-\mu_0\varepsilon}\sum_n I_{0n}L_n(\mu_0\varepsilon).$$

However, the interlinkage of the coefficients in the equation makes it necessary to compute some f_{ln}'s with $l\neq 0$ in order to arrive at the f_{0n}'s. The F_{ln}'s are determined numerically from the equation just above. We have found that the first few coefficients are sufficient for reconstructing the final distribution curve. Note that f_{00} is equal to $\int_E^\infty G_{00}dE$ and we have shown in the previous section the simplified method for its calculation. The approximations de-

scribed above were used to arrive at the f_{0n}'s and it was found once again that the difference between these values and those obtained from the exact solution was small, with the exception of the lowest portion of the energy spectrum, with $E \leqq 8$. The reader will note that it was in this energy region that the approximations were least justifiable and so a considerable error is not unexpected. Accordingly, we do not handle the low energy portion in the above manner, but will correct for it in constructing our final curve, in the next section.

The stopping power term, dE/dr, is a slowly varying function of the energy, explicitly given by Bethe,[1] which can be pretty accurately replaced by the constant value of 18 in the energy range that concerns us.

Starting from the Rutherford cross-section with relativistic and screening corrections, k_l in units of the Thomson cross-section is

$$k_l(E) = \tfrac{3}{4}z(z+1)\,\frac{E^2}{E^2-1}\,C_l(\eta)$$

where

$$C_l(\eta) = \int_{-1}^{1} \frac{1-\beta^2 \sin^2 \theta/2}{(1-\cos\theta+2\eta)^2}\,[1-P_l(\cos\theta)]\,d(\cos\theta)$$

and η is Molière's screening expression. The integral can be evaluated.*

$$C_l(\eta) = \tfrac{1}{2}l(l+1)\left(1-\ln\eta-2\sum_{m=1}^{l} m^{-1}\right) - \beta^2 \sum_{m=1}^{l} m^{-1}$$

where we put $\beta = 1$ (since we are dealing with high energies) and

$$\ln\eta = -9.43 + \tfrac{2}{3}\ln z - 2\ln E.$$

With $E \gg 1$, we thus have

$$k_l(E) = \tfrac{3}{4}z(z+1)\left[l(l+1)(5.22-\tfrac{1}{3}\ln z+\ln E) - (l^2+l+1)\sum_{m=1}^{c} m^{-1}\right].$$

* See reference 2 for details of above and references.

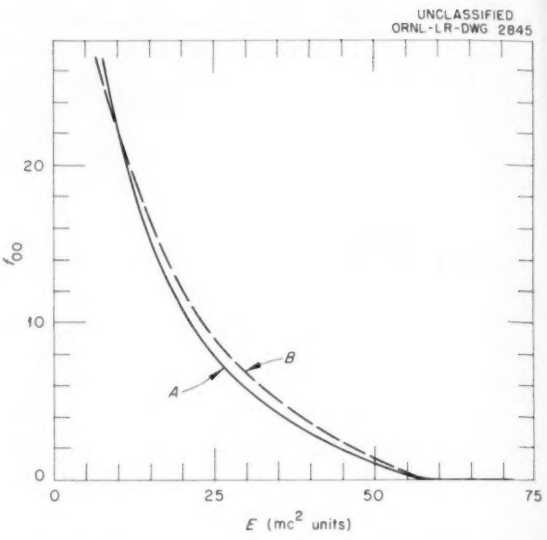

Fig. 2. f_{00} against energy. The solid line refers to the exact solution, the dashed line to the simplified solution.

These simplifications were then substituted into the f_{ln} equations together with the others described in the preceding paragraphs. Figures 2, 3, and 4 are plots of various f_{0n}'s. Curve A refers to the complete solution, Curve B to the solutions utilizing the simplifications. These simplified results are so close to those of the exact solution that we are encouraged to proceed

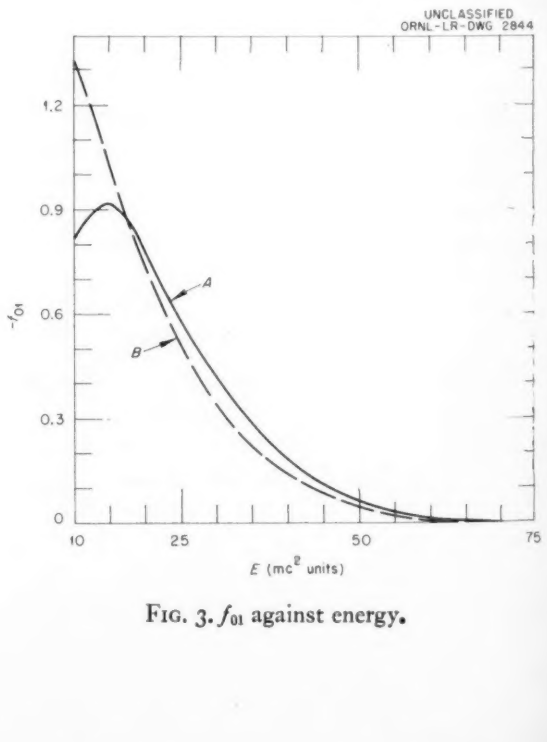

Fig. 3. f_{01} against energy.

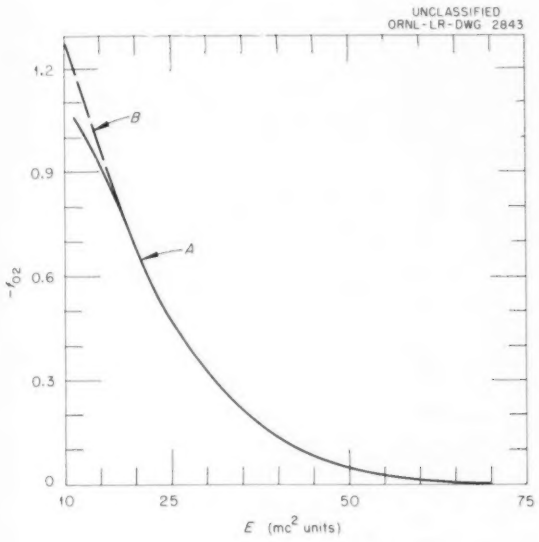

FIG. 4. f_{02} against energy.

to reconstruct the distribution from these values, a process described in the next section. A more complete discussion of the endeavors at simplification, as well as a summary of these partial results, has been completed by one of the authors.[3]

RECONSTRUCTING THE DISTRIBUTION

The weight function which approximates the attenuation of the electrons in the medium is

$$(e^{-x}-e^{-Ax}), \qquad (x=\mu_0 z),$$

a difference of exponentials. The Laguerre coefficients take into account the discrepancy between what actually happens and the weight function. We now wish to switch to a new set of polynomials orthogonal to the new weight function. These are arrived at by

$$f_{0n}'=\sum_{m=0}^{n}(-1)^n b_{nm}(A) f_{0m}$$

where the f_{0n}' are the new set of coefficients and the $b_{nm}(A)$ are functions of A, listed in Appendix B. If the weight function is adequate, and evidence indicated that it is, the set of the f_{0n}' should rapidly converge to zero. A is selected at each energy to achieve this best; we choose it such that $f_{02}'\approx 0$, with $|f_{01}'|\ll|f_{00}'|$. We note that the nth coefficient of the new set is a linear combination of the first n Laguerre coefficients and vice versa, since the nth polynomial in each case is a polynomial of order n.

The spatial reconstruction is obtained from

$$\sum_n v_n(A, x) f_{0n}'$$

where the v_n's are new orthonormal polynomials and are likewise to be found in Appendix B. We then multiply this summation by the weight function to get

$$f_0=\frac{A}{A-1}(e^{-x}-e^{-Ax})\sum_n v_n(A, x) f_{0n}'.$$

To arrive at the transition curve, we integrate f_0 over the energy spectrum from $E=76$ to $E=8$:

$$I_0=\int f_0 dE.$$

This treatment up to this point has not taken into consideration the contribution of energy below 8 mc² to the transition curve. The bremsstrahlung spectrum itself will have a portion below 8 mc². This is represented graphically in Figure 1 by that part of the area under the H_{00} curve to left of $E=8$. In this energy range we can assume the ionization to decay roughly according to the simple exponential. Thus we take $\int_0^8 H_{00}dE$, actually $8H_{00}$ since we are approximating H_{00} to be constant, and add this contribution to the exponential part of the transition curve.

Further examination will show us that there is a difference between $\int_8^{k_0} H_{00}dE$ and $\int_8^{k_0} f_{00}dE$. This "missing" energy is due to electrons scattered into the energy range below 8 mc², and hence appears in the gamma spectrum but not in the ionization spectrum. We treat this energy as if it were part of the lowest considered energy component, 8.

Including these refinements, we compute $I_0(z)$ which is plotted in Figure 5, where, for comparison, we have also included experimental data gathered by Zendle, Boag, and

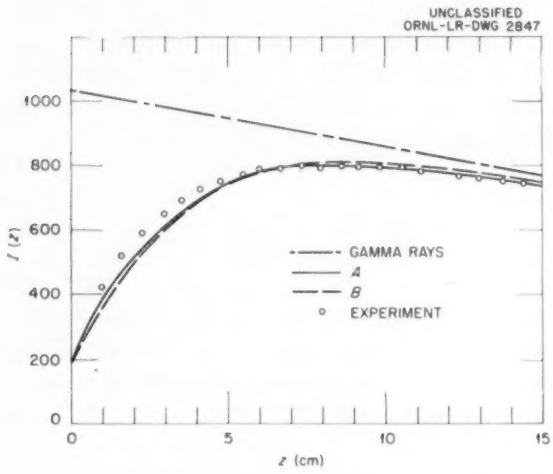

FIG. 5. The transition curve. The gamma rays are seen to decay according to an exponential and the ionization roughly according to a difference of exponentials.

Koch,[11] and the complete solution as determined by Brysk.[2] It can be seen that the agreement between theory and experiment is very good.

SUMMARY

The ionizing secondary radiation produced by a bremsstrahlung spectrum decays roughly according to a difference of exponentials. The present work has explored the simplifications that can be made for the bremsstrahlung spectrum from a betatron beam. It has been found possible to eliminate a major portion of the calculational labor hitherto associated with this problem, and to evolve a straightforward and reasonably short computational routine without appreciable loss of accuracy.

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APPENDIX A

We seek

$$G_{00}(E)=H_{00}\int_{\lambda_0}^{\lambda}\sigma\frac{d\lambda}{\lambda}=H_{00}\int_{k}^{k_0}\frac{\sigma dk}{k}$$

where k is the gamma-ray energy, and $k=\frac{1}{\lambda}$ in relativistic units. Also

$$f_{00}(E)=\int_{E}^{\infty}G_{00}dE.$$

The cross-section of the Compton part of the electron production is given in Thomson units by Nelms:[8]

$$\sigma(k,E)=\frac{3}{8}\frac{z}{k^2}\left\{\left[\frac{E}{k(k-E)}\right]^2+2+\frac{E(E-2)}{k(k-E)}\right\}.$$

The limits of integration for G_{00} are determined by the range of gamma-ray energies which will contribute to the production of electrons of energy E. The upper limit is thus k_0, the maximum energy available, and the lower limit is $\frac{1}{2}(E+\sqrt{E^2+2E})$, which can be approximated simply by E, except in terms involving log $(k-E)$, where a binomial expansion, keeping the leading terms, is used. The second integration runs over the range of possible electron energies above E. It thus has upper and lower limits of $k_0 2k_0/(2k_0+1)$ and E, respectively. The upper limit can be simplified to k_0 without loss of accuracy, except in log $(k-E)$ terms, where once again a binomial expansion is utilized. Performing these operations, the expression for the Compton part of f_{00} becomes, to $O(1/E)$:

$$f_{00}=\frac{3}{8}H_{00}z\left[-\frac{1}{2k_0}+\frac{1}{6E}+\frac{k_0-E}{k_0E}\log 2(k_0-E)-\frac{1}{E}\log\frac{k_0}{E}+\frac{E}{2k_0^2}-\frac{E^2}{6k_0^3}\right].$$

The abbreviation log refers to the natural logarithm throughout this discussion.

Similarly, for the pair production part, the cross-section expression is, to $O(1/E)$ (ref. 5):

$$\sigma(k,E)=\frac{3z(z+1)}{137\pi k}\left[1-\frac{4}{3}\frac{E(k-E)}{k^2}\right]\cdot\left[\log\frac{2E(k-E)}{k}-\frac{1}{2}\right].$$

In this case, the lower and upper limits for the first integration are $(E+1)$ and k_0 respectively, and for the second they are E and (k_0-1). The one can be disregarded in each case, except in terms involving log $(k-E)$, where in the limit at which $(k-E)=1$, the logarithm vanishes. This part of f_{00} is equal to

$$f_{00}=\frac{3^{3}(3+1)}{137\pi}\left\{\frac{7}{18}(\log k_0)^2+\frac{7}{9}\log 2\log k_0\right.$$
$$-\frac{65}{54}\log k_0-\frac{22}{27}\log 2+\frac{153}{54}$$
$$+\frac{E}{k_0}\left(-\log k_0+\log 2-\frac{167}{54}\right)$$
$$+\frac{E^2}{k_0^2}\left(\frac{1}{3}\log k_0-\frac{1}{3}\log 2+\frac{13}{27}\right)$$
$$+\frac{E^3}{27k_0^3}(-4\log k_0+4\log 2-6)$$
$$+\log E\left(-\frac{7}{9}\log 2+\frac{65}{54}\right)+\frac{E}{k_0}\log E$$
$$-\frac{E^2}{3k_0^2}\log E+\frac{4}{27}\frac{E^3}{k_0^3}\log E-\frac{7}{18}(\log E)^2$$
$$-\frac{22}{27}\log(k_0-E)+\frac{E}{k_0}\log(k_0-E)$$
$$-\frac{1}{3}\frac{E^2}{k_0^2}\log(k_0-E)+\frac{4}{27}\frac{E^3}{k_0^3}\log(k_0-E)$$
$$\left.-\frac{7}{9}\sum_{n=1}\frac{1}{n^2}\left[1-\left(\frac{E}{k_0}\right)^n\right]\right\}.$$

There is a near cancellation of positive and negative terms and therefore care should be exercised in the numerical computation; in particular, the sum in the last term should be carried out to a sufficient number of terms.

The total f_{00} is the sum of the individual f_{00}'s for Compton and pair production.

APPENDIX B

To the order $(1/A^3)$:

$$b_{00}=1$$
$$b_{10}=\frac{1}{A}\left(1-\frac{1}{2A^2}\right)$$
$$b_{11}=\left(1-\frac{1}{2A^2}\right)$$
$$b_{20}=\frac{1}{A}\left(1-\frac{2}{A^2}\right)$$
$$b_{21}=\frac{1}{A}\left(1-\frac{1}{A}\right)$$
$$b_{22}=\left(1-\frac{1}{A^2}\right)$$
$$V_n=(-1)^n\sum_{m=0}^{n}b_{nm}L_m$$
$$V_0=1$$
$$V_1=-\left[1-x+\frac{1}{A}-\frac{1}{2A^2}+\frac{x}{2A^2}-\frac{1}{2A^3}\right]$$
$$V_2=1-2x+\frac{x^2}{2}+\frac{2}{A}-\frac{x}{A}-\frac{2}{A^2}+\frac{3x}{A^2}-\frac{x^2}{2A^2}-\frac{2}{A^3}$$

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A COMPRESSION DEVICE FOR USE IN GASTRO-INTESTINAL EXAMINATIONS, WHEN THE PATIENT LIES PRONE

By ROBERT P. BARDEN, M.D.*
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MANY pioneer radiologists[1,2,3] emphasized in the early 20th century, the importance of controlled pressure in detecting lesions of the gastrointestinal tract. This principle has become so universally accepted that so-called "spot film" devices with built in compression cones are standard equipment on roentgenoscopic units in this country. Ingber,[4] of Argentina, has described the use of the modified Holzknecht spoon in glowing terms. All of these considerations, however, usually apply to the examination of the patient in the erect posture.

In the roentgen study of the stomach and duodenum, it is common experience that occasionally the duodenal cap may fill with difficulty, even if aided by skillful palpation, when the patient is erect; however, it may fill completely and more or less continuously as soon as the patient lies on the abdomen or right side. One may not be able, therefore, to obtain the maximum benefit from compression, except with the patient in the prone posture. Attempts have been made to obtain pressure upon the stomach and duodenum, and also parts of the barium filled colon, by balsa wood cones or hemispheres or by small cloth bags tightly filled with cotton, upon which the patient lies. Often the results are unsatisfactory because: graded pressure is not possible; the object used to produce it does not remain in the required position; or it is too rigid to conform to bony contours such as the lower portion of the costal cage or the bony pelvis.

It is possible to overcome these difficulties and to produce graded compression with the patient prone or prone oblique, by the use of a rubber bag which can be inflated to any desired degree and is maintained in position by a plexiglas frame† (Fig. 1 and 2). The usefulness of this device is shown in the accompanying photographs (Fig. 3 and 4). The undersurface of the handle of the banjo frame is covered with rubberized cork which prevents any slip-

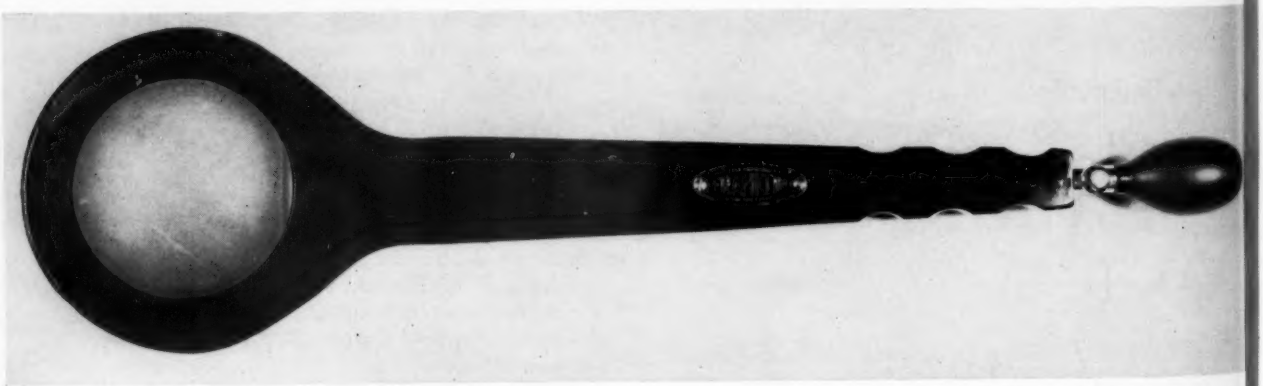

FIG. 1. Front view of inflatable rubber bag attached to banjo frame, which can be used to produce graded pressure upon the barium filled stomach, duodenum or colon when slid under a patient lying prone.

* Radiologist, Chestnut Hill Hospital, Philadelphia, Pennsylvania.
† Manufactured by the Franklin X-ray Corp., Philadelphia, Pennsylvania.

Fig. 2. Side view of compression device with bag partly inflated. Air is pumped in by the rubber bulb and released by turning the thumb screw, as in the ordinary apparatus for determining blood pressure.

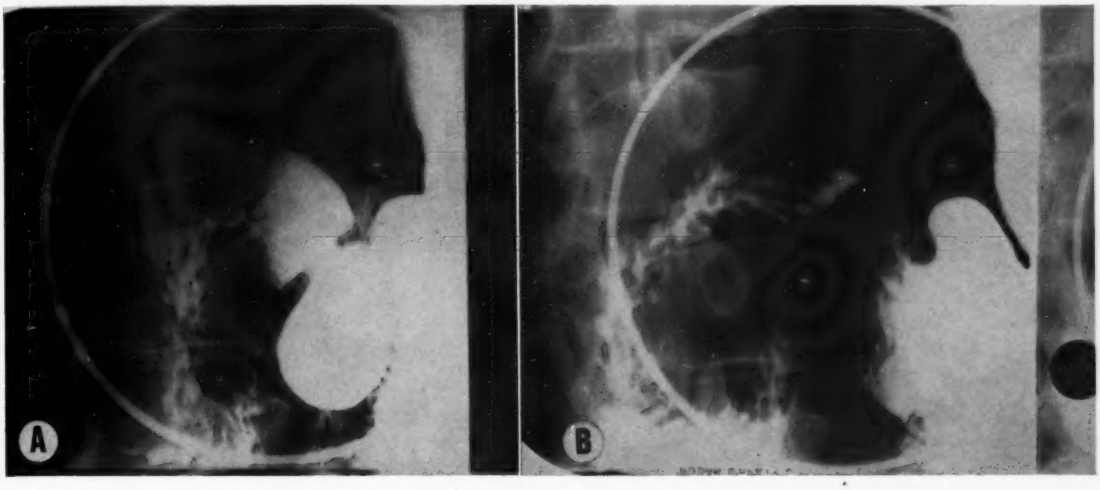

Fig. 3. (*A*) Normal duodenal cap in a patient lying in the prone oblique position. No pressure. (*B*) Same patient after inflating the pressure device. The circumference of the bag is shown by the metal ring. Note the detail of the mucosal folds in the gastric antrum and duodenal cap.

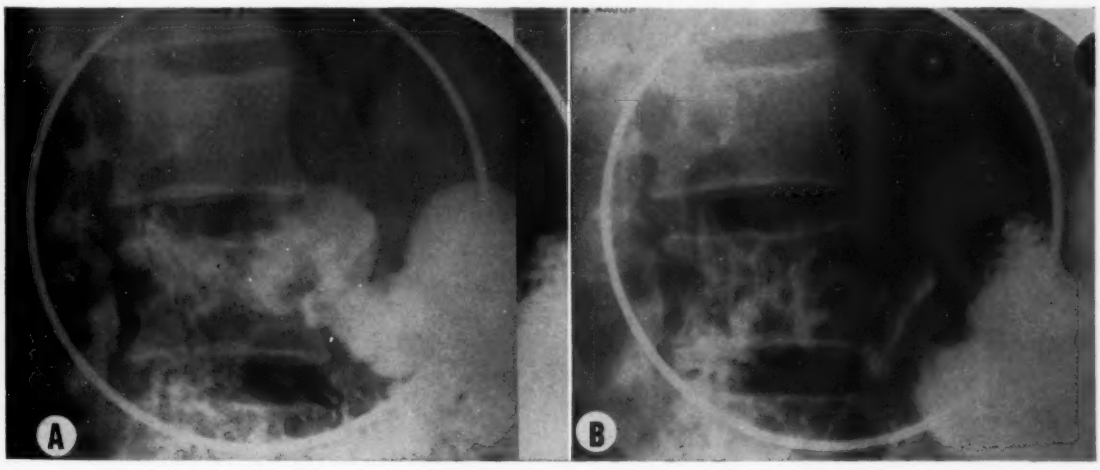

Fig. 4. (*A*) Questionable deformity of the duodenal cap in a patient lying in the prone oblique position. No pressure. (*B*) Same patient after inflating the pressure device under roentgenoscopic observation. Note the ulcer crater with surrounding edema.

ping or sliding of the bag after it is in position. An ordinary bulb with a thumb screw allows the operator to inflate or deflate the rubber bag at will during roentgenoscopic observation until the optimum degree of compression is obtained.

I wish to express my thanks to Mr. Charles W. Smith of the Franklin X-ray Corp., Philadelphia, for his cooperation in the preparation of this paper.

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Vol. 74, No. 2

NIGHT BLINDNESS AND ROENTGENOSCOPY*

By JAMES P. STEELE, M.D.
YANKTON, SOUTH DAKOTA

THE possibility of the existence of a relationship between night blindness and the ability to see objects on a fluoroscopic screen has never been fully explored as far as could be determined by a perusal of the literature available. The significance of the relationship, if any, should be of utmost importance to radiologists.

It is, of course, a well known fact that a certain small percentage, variously estimated at 1 to 5 per cent, of all persons have an inherent night blindness which no amount of therapy or training can overcome. In addition, there is an even larger group that is night blind due to overexposure to light, poor nutrition and other factors.[2,9]

As has been mentioned by Chamberlain[1] and others,[3,4,7] the detection of images on a fluoroscopic screen calls for a great amount of visual acuity and discrimination, in addition to the best possible dark adaptation due to the very low light intensities involved. Also, pre-dark adaptation exposure to light is an important factor in dark adaptation as has been so well explained by Hecht[3,4] and his co-workers, and more recently by Peckham and Harley.[6]

In order to determine whether there is a direct relationship between night vision, as it is commonly understood, and the ability to see images on the fluoroscopic screen, the experiment described below was devised and used on 207 test subjects of college level.

METHODS

Three testing devices were used on each of the subjects after dark adaptation of the individual for a minimum of thirty minutes with red goggles of density proved to be efficient.

The first device was a radium plaque adaptometer adopted and used by the United States Navy as a test for night blindness[5] during World War II (Fig. 1 and 2). Each subject was placed at a distance of 40 inches from the device and given ten opportunities to tell in which direction a very faintly illuminated "T" was pointed. The score was the number of correct responses.

The second device (Fig. 3) was an adaptometer recently presented to the profession by the United States Radium Corporation[8] which consists of five phosphorescent disks excited by radioactive strontium and varying in intensity from 0.60 to 0.0026 microlamberts. Each subject was exposed to each of the five disks at a distance of 40 inches and was scored on the number of disks visualized.

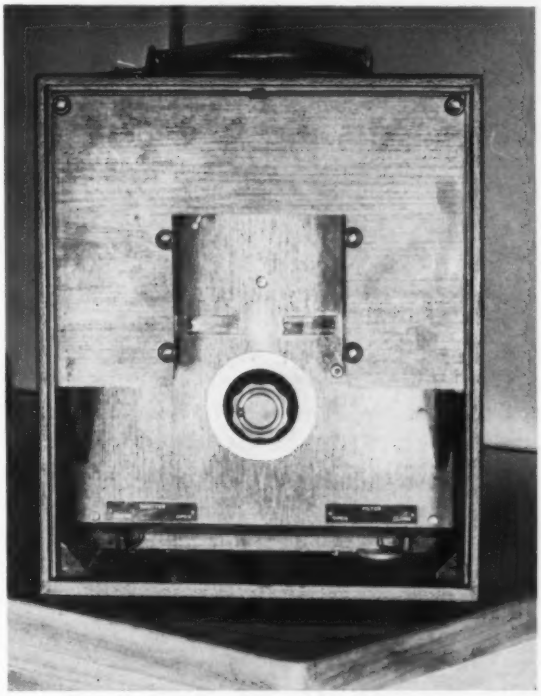

FIG. 1. Back view of radium plaque adaptometer showing operating mechanism.

The third device (Fig. 4) was originated by the author in the following manner. Abdominal measurements were taken of 400 consecutive patients in the Department of Roentgenology of this hospital and averaged, thus obtaining

* From the Department of Radiology, Sacred Heart Hospital, Yankton, South Dakota and the Department of Radiology, University of South Dakota School of Medicine, Vermillion, South Dakota.

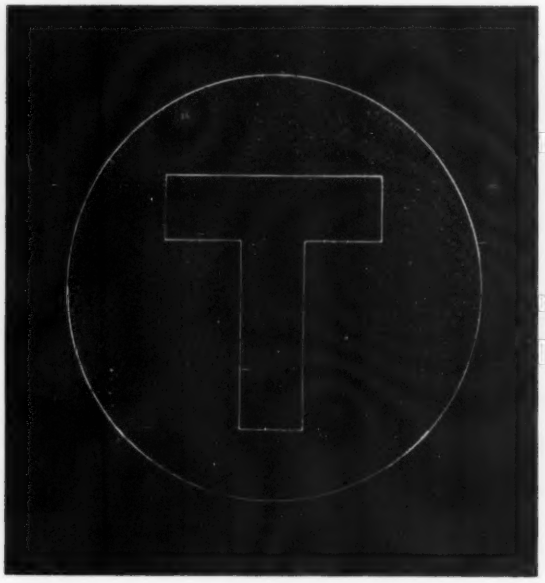

Fig. 2. Radium plaque adaptometer as seen by test subjects.

a figure theoretically the thickness of the average abdomen. A masonite presdwood phantom 18 by 24 inches in size and 25.5 cm. thick was then constructed. The thickness was determined by the average figure obtained above and corrected by a factor of 1.16 for presdwood of density 0.975 gram per cubic centimeter, according to Chamberlain's method.[1]

On this phantom were placed twelve objects of varying size and density made by mixing

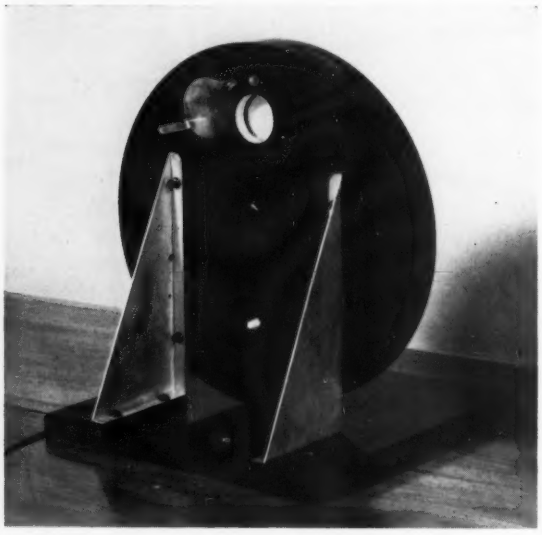

Fig. 3. Strontium disk adaptometer showing small disk seen by test subjects.

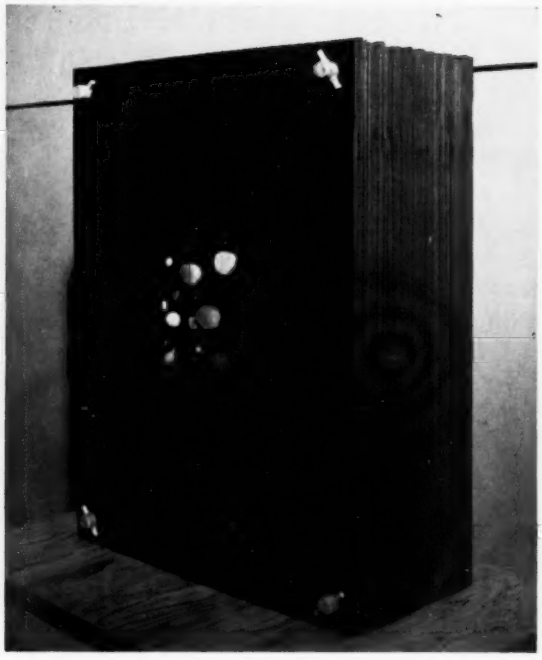

Fig. 4. Phantom of masonite presdwood showing test objects in place.

various amounts of barium sulfate with melted paraffin and then molding and cutting. Numerous objects were made originally and the twelve used in the test were selected under the fluoroscope and through the phantom so that they would range from the very obvious to those impossible to see. Several trained observers helped in the selection. The most competent could see only ten of the twelve, thus giving a theoretically good test.

During testing, the phantom was placed in position behind the fluoroscopic screen and illuminated by roentgen rays from behind the table at 80 kv. and 5 ma. The subject was asked to count the number of objects seen from a distance of 24 inches during three six-second exposures. The score was the number of objects observed.

All subjects were tested on each of the three devices in succession and all tests were conducted in total darkness. Exposure to outdoor light was essentially at the same intensity for all subjects tested and no subjects with known poor visual acuity were used.

RESULTS

The results of each of the three tests were tabulated for each of the test subjects and were then statistically analyzed at the

Table I

SUMMARY OF FINAL RESULTS OF TESTS ON 207 INDIVIDUALS BY AVERAGE SCORES

	Highest Score Possible on Test	Special Group of Nine Who Had Repeated Testing	Total Experimental Group Including Special Group
Radium plaque adaptometer	10.0	5.5	8.4
Strontium disk adaptometer	5.0	2.8	4.0
Special testing device (Fig. 3)	12.0	6.2	7.0
Total	27.0	14.5	19.4

University of South Dakota. Thirteen showed poor scores on each of the three tests. These individuals were asked to return for re-testing after having determined that none of the thirteen had any significant defects in visual acuity or discrimination. Nine of this group showed consistently poor performance on each of the three tests on repeated re-examinations following full explanation of what should be observed. The other four showed such improvement that it was assumed their poor testing was due either to lack of attention or to poor understanding. These results give a figure comparing favorably with the percentage found to be night blind in other studies and by other methods of testing.

The factor of learning in this particular experiment can be ruled out as influencing the scoring since none of the subjects had had previous experience with these testing devices and exposure to each of the three devices was the same for each person.

SUMMARY

Two hundred and seven individuals were tested for night vision using two testing devices after proper dark adaptation. A third test was designed explicitly to detect roentgenoscopic ability through a phantom constructed to be of average abdominal thickness and was used on each subject. Those making poor scores on all three tests were selected for re-testing and nine of these showed consistently poor performance on all tests (Table 1). This would tend to confirm previous figures on the percentage of night blindness.

Inexperienced subjects and relatively simple tests were chosen in order to try to eliminate such factors as improper test procedure, learning and experience, and in order to test a relatively large number of individuals.

CONCLUSIONS

(1) A definite correlation exists between night blindness and ability to see images on the fluoroscopic screen. Learning and experience will not improve this lack of night vision.

(2) The small percentage of individuals who are night blind by accepted testing methods should not engage themselves in branches of medicine requiring the use of the fluoroscope other than for the detection of large dense images.

(3) It might be suggested that all prospective residents in the field of diagnostic roentgenology be tested for night vision and those who are night blind be advised to enter some other branch of medicine if therapy with vitamins and prolonged protection from bright sunlight do not remedy their loss of night vision.

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I wish to express my appreciation to Dr. Rodger T. Davis of the University of South Dakota for his statistical analyses, to the United States Navy through Captain L. G. Jordan for the loan of the radium plaque adaptometer, to Mr. G. L. Marriott of the United States Radium Corporation for the use of the strontium disk adaptometer and to the General Electric X-ray Company and Willson Goggle Company for the dark adaptation goggles.

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Thirty-eighth Annual Meeting: Shamrock Hotel, Houston, Texas, April 9–11, 1956.

EDITORIALS

THE FIFTH INTER-AMERICAN CONGRESS OF RADIOLOGY

THE Fifth Inter-American Congress of Radiology was held at the Shoreham Hotel in Washington, D. C., April 24 to 30, inclusive, 1955. This Congress was the fifth of a series initiated by the Inter-American College of Radiology, which has permanent headquarters at Buenos Aires, Brazil. The structure of this College is patterned after that of the American College of Radiology and has for its purpose initiation of periodic Inter-American Congresses of Radiology and the strengthening of scientific and social bonds between the various radiologic societies and radiologic groups of the New World. It was organized primarily by the Latin Americans with the hope that the United States and Canada would join them in this work.

The First Congress was held in Buenos Aires in 1943 under the presidency of the late Dr. J. Merlo Gómez; but that was during the Second World War and it was not possible for any delegates from the United States or Canada to attend. The Second Congress was held in 1946 in Havana under the presidency of the late Dr. Pedro L. Fariñas; the Third Congress in Santiago, Chile, in 1949, with Dr. Felix Daza B. as president; the Fourth in Mexico in 1952 under the presidency of Dr. Manuel F. Madrazo, so well known and beloved by all his American colleagues, and the Fifth Congress has just now been held under the presidency of Dr. James T. Case, under the auspices of the American College of Radiology, acting for the various radiologic organizations of the United States.

There were 1,696 registrations, including 252 from Latin America. This means that there were more Latin American radiologists gathered in one meeting at this Congress than at any previous international congress. Dr. Case attributes the great success of this Fifth Inter-American Congress of Radiology to the wonderful collaboration of the American College of Radiology, the various officers and committeemen of the Congress, particularly, Drs. Lowell S. Goin, Eugene P. Pendergrass, Philip J. Hodes, Juan A. del Regato, and Earl E. Barth. Many other names merit mention, but particularly Drs. Earl R. Miller, C. Edgar Virden, C. Allen Good, Theodore J. Wachowski, and Mr. Clifford L. Sherratt. In addition, the DuPont, Eastman, General Electric, Keleket, Mallinckrodt, Picker, Standard, and Westinghouse companies contributed most generously to the success of the meeting, not only by their use of liberal space for commercial exhibits but by out and out contributions to the expense of the meeting. The Local Committee under the chairmanship of Dr. Frederick O. Coe and the Ladies Committee under the chairmanship of Mrs. Edgar M. McPeak were most helpful, and their very successful efforts to provide entertainment were highly appreciated.

The opening event was the Sunday afternoon tea in the beautiful building of the Pan American Union, the headquarters of the Organization of American States.

The impressive inaugural session was opened by singing of the National Anthem and the call to order by the Vice-President, Dr. Lowell S. Goin. The invocation was offered by Canon Charles Martin of Washington, D. C. Then followed the reading of a letter of welcome from the President of the United States, Dwight D. Eisenhower,

after which Vice-President Richard M. Nixon gave a hearty cordial welcome to the members of the Congress and especially those from Latin America, emphasizing the importance of inter-American collaboration. Dr. James T. Case was then formally installed as President of the Fifth Inter-American Congress of Radiology by Dr. Manuel F. Madrazo, who was President of the Fourth Inter-American Congress of Radiology and who delivered to the incoming president, the President's medal and chain, a gift from the American College of Radiology to the Inter-American College of Radiology at the meeting in Santiago in 1949.

Dr. Carlos Dávila, Secretary-General of the Organization of American States, made a very inspiring address of welcome, and gave expression to his conviction that the Congress would constitute an important step toward strengthening the bonds of Inter-American friendship. Dr. Warren W. Furey, President of the American College of Radiology, then welcomed the assembly in the name of the American College of Radiology, the actual hosts of this Congress. Dr. Pedro A. Maissa, President of the Inter-American College of Radiology, responded.

The presidential address by Dr. Case outlined in some detail the evolution of the Inter-American College of Radiology and the Inter-American Congresses of Radiology, and memorialized numerous accomplishments of our Latin American confreres in radiology throughout the years since Röntgen's discovery. He stressed the greater responsibility now resting upon the shoulders of radiologists everywhere because of the development of isotopes for research and therapy, and their participation in the general problem of protection against untoward irradiation from either warlike or peaceful uses of atomic energy. The Rt. Rev. Henry F. Grabenstein invoked the benediction.

The scientific program consisted of thirty-seven communications, many of them grouped in symposiums. The first symposium was on research aspects of cancer, with Dr. Charles S. Cameron of New York City as moderator. Alice E. Moore talked on "Viruses and Tumor Inhibition"; Harry S. N. Green on "Compatibility and Noncompatibility in Tissue Transplants"; Bergenstal, Huggins and Dao on "Effects of Adrenalectomy in Man"; Sydney Farber on "Chemotherapy of Cancer and Allied Diseases."

There was a group of papers on the treatment of carcinoma, the speakers including B. V. A. Low-Beer of San Francisco; C. E. Garciga of Havana; Maurice Lenz of New York; Pinto Vieira of Rio de Janeiro; and Charles L. Martin of Dallas.

The symposium, monitored by Leo G. Rigler of Minneapolis, on bronchogenic carcinoma, included papers by Rigler, Ackerman, Garland and associates, Gilliam, and finally by S. Di Rienzo of Cordoba.

Another symposium discussed intravenous cholangiography, with Esguerra-Gómez of Bogotá and Gonzales Peña of Havana; Shehadi and McClenahan of New York discussed the subject.

A symposium of high voltage was monitored by Robert S. Stone, and included papers by Watson on twenty million volt therapy; Carpender on radioactive cobalt, Buschke on million volt roentgen therapy; and Haas and Harvey on external beta particle beam therapy. The final symposium on Friday morning was devoted to the clinical application of isotopes, with Richard Chamberlain as moderator, and Robert Robbins, Edith Quimby, and J. P. Storaasli as participants.

In addition to these symposiums there were numerous "free" papers, many of exceptional value. Special mention is merited by George E. Pfahler for his paper and exhibit on "Radiation Therapy in Cavernous Hemangioma."

On Thursday night, April 28, at the banquet of the Congress, medals were presented to Drs. George E. Pfahler, James T. Case, and Juan A. del Regato. Dr. Pfahler received the 1952 medal voted by the Cen-

tre Antoine Béclère of Paris, the medal being conferred personally by Miss Antoinette Béclère, the daughter of the famous and well-loved Antoine Béclère, dean of French radiologists, in whose memory the Centre was established. The Ambassador from Cuba presented Drs. Case and del Regato with the medal of Officer of the Order of Merit of Carlos Finlay, in honor of the man who was the first to discover the *Stegomyia fasciatus* as the cause of yellow fever. The Ambassador from Colombia also conferred on Dr. Case the Order of Merit of Boyacá. These awards were conferred in recognition of the contributions of Drs. Case and del Regato to Latin American radiology.

After the banquet there was a special convocation of the American College of Radiology for the purpose of awarding Honorary Fellowship to Dr. Pedro A. Maissa of Buenos Aires and Dr. José Maria Cabello Campos of Sao Paulo. Dr. Case was also given the gold medal of the American College of Radiology "for distinguished and extraordinary service to the American College of Radiology and to the profession."

There were more than fifty-one exhibits—enough to occupy all of one's time if careful study were given each exhibit. The fifteen Refresher Courses were well attended and much appreciated. Several of these were given in Spanish.

The social events of the Congress included the tea at the Pan American Union, already mentioned; receptions by DuPont, General Electric, Keleket and Picker. An unexpected by unforgettable pleasure was experienced by those who heard the piano concert by Mrs. Lowell S. Goin on Tuesday evening. On Wednesday evening, Eugene Ormandy and the Philadelphia Orchestra, with the General Electric Corporation as host, gave a wonderful concert at Constitution Hall to those in attendance at the Congress. The Westinghouse Corporation was host to the radiologists for luncheon and a trip to Baltimore to visit the Westinghouse offices, showrooms, and factory; and to the ladies for a private luncheon and for a Washington sightseeing trip. On Saturday the Standard X-ray Corporation furnished the transportation for a day spent at the National Institutes of Health, special instruction and entertainment being offered by the National Cancer Institute; and for the ladies a luncheon and a trip to Annapolis.

Concurrent with the scientific and social program of the Inter-American Congress of Radiology were the meetings of the Counselors and the final meeting on Friday of the Fellows of the Inter-American College of Radiology in the cloture session of the Congress. The gold medal of the Inter-American College of Radiology was voted to Dr. James T. Case of Santa Barbara, California and to Dr. Pedro A. Maissa of Buenos Aires. A silver medal was presented to Dr. Oscar F. Noguera of Buenos Aires for the best paper published during the last three years in the *Acta Radiológica Interamericana*, the official publication of the Inter-American College of Radiology. A silver medal was also voted to Dr. Luis Arrieta Sanchez of Panama for his outstanding contributions to Latin American radiology.

The next (the sixth) Inter-American Congress of Radiology is planned for 1958 in Lima, Perú, with Dr. Oscar Soto as president.

RAYMOND R. MACHLETT
1900-1955

RAYMOND R. MACHLETT, President of Machlett Laboratories, was well known to the radiological world through his great scientific interest in radiology and through helping radiology to perfect some of its most important details. To this end, he lent his knowledge and genius in the development and manufacture of various types of roentgen-ray tubes which were designed primarily for their utilitarian as well as for their durable qualities in radiological work. To Mr. Machlett and those associated with him in his manufacturing interests the radiological world is grateful and it is with regret that the announcement is made of his death which occurred on Friday, January 7, 1955. It has brought a great sense of loss to science and particularly to radiology.

The following paragraphs from a memorial to Mr. Machlett published by the Cathode Press seem most appropriate.

"Raymond Machlett regarded the affection and respect of his family and friends and associates as his most valued possession. He had an unusual capacity for love and friendship and his generosity and devotion to the well-being of his fellow men was unbounded. He had the gift of leadership and used it wisely and with kindness. Enthusiasm, sincerity of thought and pride in accomplishment, and the accomplishments of his associates, were among his fine qualities. He was both teacher and scholar and applied his creative genius and knowledge of science to directions which benefited all mankind. He loved the great outdoors and all of nature and was happiest when sharing its beauties and its treasures with those who were dear to him.

"Above all, he enjoyed life . . . and living . . . and the sharing of its blessings with his family, associates, and friends. To those who were privileged to work with him, he gave over years of close association, much of himself."

The members of the American Roentgen Ray Society join his family and friends in an expression of regret in the great loss which science in general and radiology in particular has sustained in the death of so capable a scientist and worker as Raymond Machlett.

AMERICAN ROENTGEN RAY SOCIETY

SECTION ON INSTRUCTION

Harry M. Weber, M.D., *Director*

Titles and Abstracts of Courses offered

Fifty-Sixth Annual Meeting
Palmer House, Chicago, Illinois
September 20–23, 1955

PRESIDENT-ELECT PAUL C. HODGES, with the approval of the Executive Council, has requested that the Section on Instruction be continued for the annual meeting of 1955. His program has been arranged so that the Instruction Courses will be offered between the hours of 3:00 P.M. and 4:30 P.M. on Tuesday, Wednesday, and Thursday, and 1:30 and and 3:00 P.M. on Friday. Thus a total of 90 minutes has been made available for each course. This makes it possible for instructors to devote sufficient time to discussion and to conference with those attending the courses. No other official activity has been scheduled for these times.

The Section on Instruction presents for 1955:

(1) A series of 4 Single Period Courses (Courses 101–104) dealing with fundamental and practical features of Nuclear Medicine, with a faculty of 4 instructors and covering 4 periods.

(2) Eleven Single Period Courses dealing with Therapeutic Radiology and with fundamental physical, biologic and dosimetric aspects of Radiology, with a faculty of 17 instructors, and covering 11 periods.

(3) Seventeen Single Period Courses (Courses 301–317), and six Sequential Courses (Courses 401–406) in Diagnostic Roentgenology with a faculty of 23 instructors, and covering 31 periods.

GENERAL INFORMATION

THE FACULTY

1. Paul C. Aebersold, Ph.D., Chief of the Isotope Branch, U. S. Atomic Energy Commission, Oak Ridge, Tennessee.
2. Bernice B. Borrman, B.A., Radiological Physicist, Section of Biophysics and Biophysical Research, Mayo Clinic, Rochester, Minnesota.
3. Byron G. Brogdon, M.D., Resident in Radiology, University of Arkansas Medical Center, Little Rock, Arkansas.
4. Frank L. Campeti, M.D., Associate in Radiology, Department of Radiology, University of Rochester School of Medicine and Dentistry, Rochester, New York.
5. Lois Cowan Collins, M.D., Assistant Radiologist, Anderson Hospital for Cancer Research; Associate Professor of Radiology, Baylor University College of Medicine, Houston, Texas.
6. Vincent P. Collins, M.D., Professor and Chairman of Department of Radiology, Baylor University College of Medicine; Radiologist-in-Chief, Jefferson Davis Hospital, Houston, Texas.
7. George Cooper, Jr., M.D., Professor of Roentgenology, University of Virginia, Charlottesville, Virginia.
8. Charles T. Dotter, M.D., Professor and Head, Department of Radiology, University of Oregon Medical School, Portland, Oregon.
9. Theodore P. Eberhard, M.D., Clinical Professor of Radiology and Coordinator of Cancer Teaching, Jefferson Medical College; Associate Radiology, Jefferson Hospital; Visiting Lecturer, School of Medicine, University of Pennsylvania.
10. Titus C. Evans, Ph.D., Head, Radiation Research Laboratory, College of Medicine, State University of Iowa, Iowa City, Iowa.
11. Melvin M. Figley, M.D., Assistant Professor of Radiology, University of Michigan Medical School and University Hospital, Ann Arbor, Michigan.
12. Robert E. Fricke, M.D., F.A.C.R., Associate Professor of Radiology, Mayo Foundation, University of Minnesota; Consultant in Section on Therapeutic Radiology, Mayo Clinic, Rochester, Minnesota.
13. Hymer L. Friedell, M.D., Professor of Radiol-

ogy, Western Reserve University; Director, Department of Radiology, University Hospitals, Cleveland, Ohio.

14. John W. Hope, M.D., Assistant Professor of Radiology in the Graduate School and the Undergraduate School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania.

15. Morton M. Kligerman, M.D., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; Assistant Attending Radiologist, Presbyterian Hospital, New York, New York.

16. Macmillan, A. S., M.D., Radiologist, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts.

17. Richard H. Marshak, M.D., Associate Radiologist, Mt. Sinai Hospital, New York, New York.

18. Charles L. Martin, M.D., Professor of Radiology, Southwestern Medical College, Dallas, Texas.

19. Isadore Meschan, M.D., Professor and Head, Department of Radiology, University of Arkansas School of Medicine, Little Rock, Arkansas.

20. J. E. Miller, M.D., Associate Professor of Radiology, Southwestern Medical School of the University of Texas; Radiologist, Baylor Hospital, Dallas, Texas.

21. William T. Moss, M.D., Chief, Therapeutic Radiology, Veterans Administration Research Hospital, Chicago, Illinois; Associate in Radiology, Department of Radiology, Northwestern University School of Medicine, Chicago, Illinois.

22. T. H. Oddie, D.Sc., F. Inst. P., University of Arkansas Medical Center, Little Rock, Arkansas.

23. Charles A. Owen, M.D., Assistant Professor of Clinical Pathology, Mayo Foundation, University of Minnesota; Consultant, Section of Clinical Pathology, Mayo Clinic, Rochester, Minnesota.

24. H. M. Parker, M.Sc., F. Inst. P., Nucleonics Division, General Electric Company, Richland, Washington.

25. Lester W. Paul, M.D., Professor of Radiology, University of Wisconsin Medical School, Madison, Wisconsin.

26. Harold O. Peterson, M.D., Clinical Associate, Professor of Radiology, University of Minnesota, Minneapolis, Minnesota; Radiologist to Miller Hospital and Children's Hospital, St. Paul, Minnesota.

27. Edith H. Quimby, Sc.D., Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York, New York.

28. Paul A. Riemenschneider, M.D., Associate Professor of Radiology, State University of New York, Upstate Medical Center; Radiologist, Syracuse Memorial Hospital, Syracuse, New York (on leave of absence); Radiologist, U. S. Naval Hospital, Portsmouth, Virginia.

29. Patrick Riley, M.D., Associate in Radiology, Northwestern University Medical School; Associate Radiologist, Chicago Wesley Memorial Hospital, Chicago, Illinois.

30. J. Maurice Robinson, M.D., Assistant Clinical Professor of Radiology, Stanford University School of Medicine, San Francisco, California.

31. Frederick A. Rose, M.D., Assistant Professor of Radiology, Western Reserve University Medical School, Cleveland, Ohio.

32. Richard Schatzki, M.D., Radiologist, Mount Auburn Hospital, Cambridge, Massachusetts.

33. William Snow, M.D., Radiologist, Confederate Memorial Medical Center, and Veterans Administration Hospital, Shreveport, Louisiana.

34. K. W. Stenstrom, Ph.D., Professor of Biophysics and Director of Radiation Therapy; University of Minnesota Medical School, Minneapolis, Minnesota.

35. Clyde A. Stevenson, M.D., Head of the Department of Radiology, Scott and White Clinic, Temple, Texas; Professor of Radiology, University of Texas Post-graduate School.

36. F. E. Templeton, M.D., Professor of Radiology, University of Washington Medical School, Seattle, Washington.

37. Arthur S. Tucker, M.D., Radiologist, Cleveland Clinic; Instructor in Radiology, Frank C. Bunts Educational Institute.

38. Eugene F. Van Epps, M.D., Professor and Head of Radiology, University of Iowa College of Medicine, Iowa City, Iowa.

39. Martin Van Herik, M.D., Consultant in Therapeutic Radiology; Instructor in Radiology, Mayo Foundation, University of Minnesota.

40. H. Vermund, M.D., Ph.D., Assistant Professor, Department of Radiology; University of Minnesota Medical School, Minneapolis, Minnesota.

41. Marvin M. D. Williams, Ph.D., Professor of Biophysics, Mayo Foundation, University of Minnesota; Consultant, Section of Biophysics and Biophysical Research, Mayo Clinic, Rochester, Minnesota.

42. Manuel O. Zariquiey, M.D., Assistant in Radiology, Department of Radiology, University of Rochester, School of Medicine and Dentistry, Rochester, New York.

Conference Periods

Tuesday, Wednesday, Thursday and Friday afternoons

Single Periods.....3:00–4:30 P.M.
(Tuesday, Wednesday and Thursday)

Single Periods.....1:30–3:00 P.M.
(Friday)

Location

Instruction Courses will be held in Rooms 907W, 908W, 910W, 917, 919, 920, 941W, 942W, 944W, 955W, 957W, 959W, which are located on the Ninth Floor of the Palmer House.

On Sunday afternoon, beginning at 1:00 P.M., or whenever the main registration desk is opened up, and until 5:00 P.M., and on Monday, from 8:30 A.M. until 4:30 P.M. the Section on Instruction will have a registration desk in the main registration area.

On all of the succeeding days of the meeting the registration desk of the Section on Instruction will be located off the elevator lobby on the Ninth Floor in Parlor 01-W.

Code

The instruction periods will be designated with the following code:

T, Tuesday.....3:00–4:30 P.M.
W, Wednesday.....3:00–4:30 P.M.
Th, Thursday.....3:00–4:30 P.M.
F, Friday.....1:30–3:00 P.M.

How to Register and Obtain Tickets for the Instruction Courses

Admission to the Instruction Courses will be by ticket only.

Following the list of titles and abstracts is a *general order sheet.* First, second and third choices for each period should be selected carefully and indicated on the order sheet. The rooms in which the courses will be given are comparatively small ones so it will be necessary to place a limitation on the number of persons who will be able to attend individual courses. It is estimated that the number who can attend will range between 30 and 40 persons. If the directions given on the order sheet are followed explicitly, errors in completing reservations for the courses will be minimized.

It is possible for one to attend only four periods of instruction, so the condensed schedule given on the last pages of this program should be consulted with care when registering and ordering tickets for the courses.

Reservations for the courses will be made in the order in which the order forms are received. Those who are not members of the American Roentgen Ray Society will be charged the nominal fee of $2.00 per period of instruction, or a maximum fee of $7.00 for four periods. Full-time graduate students in radiology will be admitted without fee, but they will be required to make application for the courses they wish to attend.

Previous to September 10, 1955, the order forms should be sent to the Director, Dr. Harry M. Weber, Mayo Clinic, Rochester, Minnesota. After September 10, 1955, the order forms should be sent directly to Dr. Harry M. Weber, Palmer House, Chicago, Illinois.

To avoid the confusion always existing on the first days of the meeting, a set of tickets will be mailed to each person whose registration for courses reaches the office of the Director on or before September 10, 1955. The envelope containing the tickets will be labelled in a conspicuous manner. Registrants are urged to be on the lookout for their tickets, and to bring them to the meeting. The success of this plan depends entirely on the cooperation of the registrants.

In case the courses are not filled by the time of the meeting, tickets will be available at the registration desk of the Section on Instruction on Sunday, September 18, and thereafter during the meeting.

Holders of Tickets

Those who do not have the proper ticket for the course they wish to attend will not be permitted to enter the room. An attendant will be at the door of each conference room to collect the tickets.

DESCRIPTION OF COURSES

COURSE 201

Room 905W **Period: T**

MARTIN VAN HERIK, M.D.
ROBERT E. FRICKE, M.D.
Rochester, Minnesota

The Treatment of Carcinoma of the Cervix Uteri

This discussion will include:

(a) Principles of treatment.
(b) Technique of radium and roentgen therapy, with emphasis on the intensive, divided-dose method of radium therapy including its advantages and disadvantages.
(c) Dosage.
(d) Results.
(e) Treatment of recurrent carcinoma of cervix and results.

COURSE 203

Room 955W **Period: T**

MARVIN M. D. WILLIAMS, Ph.D.
BERNICE B. BORRMAN, B.A.
Rochester, Minnesota

The Thorough Calibration of an X-Ray Machine

The calibration of an x-ray machine should include more than the determination of the roentgens per minute and the half-value layer at the center of the field. Examples of the importance of other information will be presented. Techniques of obtaining data and some of the common sources of error will be discussed.

COURSE 207

Room 957W **Period: T**

TITUS C. EVANS, Ph.D.
Iowa City, Iowa

Radiation Biology

Current concepts of biologic effects of ionizing radiation will be discussed. Emphasis, in so far as possible, will be given to aspects of interest to fields of radiation therapy and radiation protection.

COURSE 101

Room 917 **Period: T**

PAUL C. AEBERSOLD, Ph.D.
Oak Ridge, Tennessee

Recommendations on Training and Facilities for Nuclear Medicine

Over a thousand United States medical groups now use radioisotopes for diagnosis and therapy. Many clinical applications are well accepted and even a limited radioisotope program can be useful to almost any large or medium-sized hospital. Also a number of applications are suitable for use in private practice. All uses of reactor-produced radioisotopes including medical, require a license from the Atomic Energy Commission. The criteria for a license for clinical applications are based on radiological safety considerations of the use and not on medical worth. The applicant must be equipped for proper safety of use in basic training on radioisotope techniques, clinical radioisotope experience, instrumentation and facilities. The Commission with the help of qualified medical advisers has established recommendations for minimum criteria of basic training and clinical experience for the more routine clinical uses. Recommendations are also available on desirable types of equipment for specific situations.

These criteria and recommendations will be discussed for typical uses and situations ranging from limited diagnostic use in private office practice to a broad therapeutic program in a large hospital. Discussion will be invited on the major problem of scope and availability of desirable training and experience.

COURSE 305

Room 910W **Period: T**

MANUEL O. ZARIQUIEY, M.D.
FRANK L. CAMPETI, M.D.
Rochester, New York

The Bronchopulmonary Segment as a Functional Unit

This course demonstrates graphically the bronchopulmonary segments from the radiologist's point of view.

No such demonstration, of course, could or should be expected to represent the true morphology of all lungs since the variations within the normal range are so many. The aim rather is to show the trend or pattern of the segments. Photographs, drawings, diagrams, roentgenograms, plastic models, and cinefluorographic sequences will be used in this demonstration. Some of the lung specimens shown in the photographs were prepared by Charles E. Tobin, Ph.D., Department of Anatomy, University of Rochester.

COURSE 309

Room 920 **Period: T**

A. S. MACMILLAN, M.D.
Boston, Massachusetts

Roentgen Examination of the Sinuses

I. Roentgen examination of the sinuses is a very important part of the diagnosis of pathology in these locations. The rhinologist is dependent upon a correct interpretation of the sinus roentgenograms. The findings should be reported in terms of pathology, and not in the indefinite roentgenologic terms so often used. In this presentation, the technique of examination and interpretation will be considered as fully as time will allow.

COURSE 315

Room 944W **Period: T**

RICHARD H. MARSHAK. M.D.
New York, New York

Roentgen Diagnosis of Nonmalignant Lesions of the Small Intestine

This course will consist of a review of the following:

1. (a) Technique
   (b) Various barium preparations used in small intestinal studies.
2. Inflammatory lesions of small intestine including
   (a) Regional enteritis
   (b) Inflammatory lesions of the small intestine following colectomy and ileostomy for ulcerative colitis
   (c) Ileocolitis, nonspecific and specific varieties.
3. Noninflammatory lesions such as sprue, allergy, hypoproteinemia, pancreatic disease, pellagra, etc. These latter diseases have been described under various general terms. The pattern, however, in many of these conditions is sufficiently distinctive to warrant a differential diagnosis.
4. Infarction of the small intestine.

COURSE 317

Room 959W **Period: T**

WILLIAM SNOW, M.D.
Shreveport, Louisiana

Roentgenology in Obstetrics

The aim in this course is to present a simple rapid roentgenologic method of making accurate and practical measurements of the female pelvis and fetal skull in pregnancy. With the roentgenologic procedures discussed and illustrated in this period it is possible to classify obstetrical cases into three important groups: (a) normal; (b) borderline; (c) those requiring surgical intervention. The manner in which the roentgenologist and the obstetrician collaborate in the complications of pregnancy will be emphasized.

COURSE 401A
and
COURSE 401B

Room 908W **Periods: T W**

F. E. TEMPLETON, M.D.
Seattle, Washington

Roentgenology of the Pharynx and Esophagus

The aim of this course is to present the contribution of roentgenologic procedures to the diagnosis of organic and functional abnormalities of deglutition. The course will be divided into two parts:

COURSE 401A

Room 908W **Period: T**

Conduct of the examination and description of the normal roentgenologic appearances observed in various phases of deglutition.

COURSE 401B

Room 908W **Period: W**

Abnormalities observed will be described. Special attention will be given to the lesions of pharyngeal and cricopharyngeal regions, to cardiospasm and to the differential diagnosis of this condition.

COURSE 403A
and
COURSE 403B

Room 919 **Periods: T W**

JOHN W. HOPE, M.D.
Philadelphia, Pennsylvania

Problems in Pediatric Roentgenology

In many departments of radiology the thinking is in terms of adults. That infants and children, and the diseases and abnormalities with which they may be afflicted, differ greatly from grown-ups is not appreciated generally enough. Children, especially infants, are too often examined without enthusiasm and genuine interest both by technicians and radiologists. It is the purpose of these courses to point out the fallacy of this point of view, and to present workable methods of obtaining adequate diagnostic roentgenologic studies of these young patients.

COURSE 403A

Room 919 **Period: T**

Pediatric roentgenology of the neck, thorax, genitourinary tract, and the use of air as a contrast medium in the demonstration of abdominal abnormalities.

COURSE 403B

Room 919 **Period: W**

Pediatric roentgenology of the skull, gastrointestinal tract, and extremities.

COURSE 404A

Room 941W **Period: T**

HAROLD O. PETERSON, M.D.
St. Paul, Minnesota

The Normal Skull

This will be a detailed review of the pertinent and practical aspects of the roentgenologic appearance of the normal skull. Interesting anatomic features, including normal variations and artefacts, will be discussed in detail. At all times emphasis will be placed on a practical approach to the interpretation of standard roentgenographic projections of the skull. A few ideas on the roentgenographic technique will also be included.

COURSES 405A 405B 405C

Room 942W **Periods T W Th**

J. E. MILLER, M.D.
Dallas, Texas

Cardiologic Diagnosis with Conventional Roentgenologic Methods

The conventional roentgen examination of the heart and great vessels should be regarded as a most important part of the clinical examination of these structures. Much can be learned concerning the anatomy, physiology, and pathology of the heart and great vessels from fluoroscopy and adequate film study. The course is designed to help residents in radiology and radiologists who have little or no opportunity to do angiocardiography, cardiac catheterization and other special studies of the heart and great vessels. The value of the study of the heart and great vessels with conventional roentgenologic maneuvers is directly proportional to the radiologic examiner's knowledge of cardiac anatomy, physiology and pathology.

COURSE 405A

Room 942W **Period: T**

This course will discuss the technique of the conventional roentgen examination of the heart and great vessels as well as analysis of disproportionate chamber enlargement. The significance of disproportionate enlargement of the various chambers or combination of chambers will be discussed. The remainder of the first period will be concerned with a discussion and analysis of the *acquired* abnormalities of the heart and great vessels.

COURSE 405B

Room 942W **Period: W**

In this course the *congenital* abnormalities of the heart and great vessels will be discussed insofar as the conventional roentgen examination is concerned. Angiocardiograms and catheterization data will be used wherever necessary to prove diagnosis or impressions made on the conventional films. Pertinent clinical data with which the radiologist should be familiar will be used throughout these courses.

COURSE 405C

Room 942W **Period: Th**

This course will be a quiz session covering the data presented in Courses 405A and 405B. If important omissions occur during the first two courses because of the lack of time they will be picked up at this time. The session will consist of objective interpretation of films combined with the differential diagnosis based on this information. If the diagnosis cannot be made from the conventional films the individual being questioned will be expected to ask the proper questions to arrive at the correct diagnosis with the clinical data. Finally angiocardiographic catheterization, operative or autopsy data will be given to prove the diagnosis.

COURSE 204

Room 955W **Period: W**

EDITH H. QUIMBY, Sc.D.
MORTON M. KLIGERMAN, M.D.
New York, New York

Practical Clinical Techniques in Rotation Therapy

The term rotation therapy is usually applied to the procedure in which the sitting or standing patient is rotated in a horizontal beam of roentgen rays. However, exactly the same considerations are applicable to the case where the tube revolves around a recumbent patient. Various other relative patient-beam motions are also employed. The discussion in this course will be limited to vertical, or "long-axis" rotation.

This procedure may be considered an extreme utilization of the technique of cross-firing, since by rotation of the patient there are effectively an infinite number of portals of entry. The method is very useful with roentgen rays in the 200–250 kv. range; it should be available in every radiotherapy department. The rotation unit should be regarded simply as another tool to improve administration of radiation therapy, not as an isolated treatment method.

For any particular lesion, the aim of therapy is to irradiate the tumor uniformly, with the best possible differential between doses to the tumor and other tissues, and with the least possible discomfort to the patient. To this end, in many cases, rotation, or a combination of fixed fields and partial rotation may well be the method of choice.

Examples will be discussed of various treatment plans, depending on the size and location of the tumor. Central lesions and relatively small eccentric ones are treated by simple continuous rotation, with the center of the tumor on the axis of rotation. Large eccentric lesions or superficial lesions are better treated by a stationary port on the side nearer the tumor, and partial rotation through an arc of from 120° to 240° on the opposite side. Large eccentric deep-seated lesions may be treated by partial rotation over two areas, one close to the tumor and the other directly opposite, the more distant one being treated for a longer period. Bolus material must be used to equalize body contours, when the lesion extends through regions of markedly different dimensions, as in the head and neck.

A simple method of dosage calculation will be demonstrated. This is based on use of standard isodose charts, and is particularly appropriate for use with roentgen rays generated at 200–250 kv.

The purpose of the course is to show the advantages of the rotation procedure in various types of lesions, and to demonstrate the ease with which it can be employed.

COURSE 209

Room 957W **Period: W**

THEODORE P. EBERHARD, M.D.
Philadelphia, Pennsylvania

The Treatment of Malignant Tumors of the Skin

The treatment of cutaneous malignancy starts with accurate diagnosis. The clinical appearance can be completely deceiving, making biopsy mandatory. This is a simple procedure which every radiotherapist should be prepared to do.

After the diagnosis is made, the physician must classify the lesion as (1) amenable *only* to surgery, (2) amenable *only* to radiotherapy, (3) equally curable by either method. In category 3, the choice of therapy must be made on the basis of location, size, function, cosmetics, and cost.

Radiotherapeutic treatment may be interstitial or external, by roentgen-ray machines or radioactive elements, rapid or slow. Every method has its advantages and drawbacks.

The course will first demonstrate by lantern slides a wide variety of lesions and the technique of biopsy. The basis of the choice of therapy will then be discussed and illustrated. The second half of the course will be devoted to a detailed consideration of therapeutic techniques, with consideration of time-dose relationships, the choice of half-value layer and distance, and the use of protective shields.

COURSE 211

Room 959W **Period: W**

H. VERMUND, M.D., Ph.D.
K. W. STENSTROM, Ph.D.
Minneapolis, Minnesota

Radiation Effects on Malignant Tumors

Current concepts regarding the direct and indirect effects of radiations on malignant tumors will be discussed and experiments dealing with use of radioactive phosphorus as a tracer for determining radiation effects on experimental tumors will be described. Investigations regarding the relative significance of pre- and post-transplantation irradiation in mice and its implications for a better understanding of the host-tissue reaction in clinical radiation therapy will be discussed.

COURSE 102

Room 917 **Period: W**

TITUS C. EVANS, Ph.D.
Iowa City, Iowa

The Scope of Nuclear Medicine

This is an introductory survey of the field designed for those beginning or planning to begin work with radioisotopes. Physics and chemistry of radioisotopes will be discussed in simplified terms. Certain advantages and certain limitations of radioisotopes will be mentioned briefly.

General uses of radioisotopes in diagnosis, therapy, research and teaching will be outlined.

Among other topics which may be discussed are the practical ones of organization and administration, such as procurement procedures, instrumentation, radiation protection, storage and disposal.

COURSE 301

Room 905W **Period: W**

FREDERICK A. ROSE, M.D.
HYMER L. FRIEDELL, M.D.
Cleveland, Ohio

Microfilming Roentgenograms for Filing Purposes

Microfilming is becoming increasingly important to conserve storage space. The problem will be reviewed under the following headings:

1. Criteria for suitable copies.
2. Photographic methods and materials.
3. Copying apparatus.
4. Methods of filing copies.
5. Legal status of microfilms.
6. Discussion of cost per film and case.

COURSE 306

Room 910W **Period: W**

MELVIN M. FIGLEY, M.D.
Ann Arbor, Michigan

Splenoportography

The recent development of splenoportography for the first time places the portal venous system, and through it the parenchyma of the liver, in a position for safe and relatively simple direct roentgenologic examination. Following a brief discussion of the background of this technique, the details of its performance, its indications and its hazards will be discussed. An effort will be made to describe its limitations and its eventual place in our radiologic armamentarium.

COURSE 310

Room 920 **Period: W**

A. S. MACMILLAN, M.D.
Boston, Massachusetts

Roentgen Examination of the Mastoids

2. The use of chemotherapy and antibiotics has greatly changed the course of infection in the mastoid. Pediatricians and general medical practitioners sometimes feel competent to treat this condition, but too often the treatment is inadequate. The roentgenologic examination of the mastoid is the only dependable source of information. This should be recognized because mastoiditis is still prevalent. Acute and chronic infections of the mastoid and the complications will be discussed.

COURSE 316

Room 944W **Period: W**

LOIS COWAN COLLINS, M.D.
Houston, Texas

Problems in Bone Interpretation in Children

There are localized and generalized diseases which are peculiar to the skeleton of children as opposed to adults. Certain disorders and abnormalities of bone which are common to children and adults have different manifestations due to active growth and development in childhood. An approach to differential diagnosis in pediatric bone disease will be developed.

COURSE 404B

Room 941W **Period: W**

HAROLD O. PETERSON, M.D.
St. Paul, Minnesota

The Abnormal Skull

In this session the abnormalities of the skull which can be recognized on plain films will be discussed and illustrated. Again a practical everyday approach will be stressed.

COURSE 103

Room 917 **Period: Th**

HYMER L. FRIEDELL, M.D.
Cleveland, Ohio

Nuclear Medicine: Therapeutic Applications

The therapeutic applications of the following radioactive isotopes will be discussed:

1. Radioactive iodine for diseases of the thyroid, including ablation of the normal thyroid for heart disease.
2. Radioactive phosphorus for polycythemia, leukemia, and certain metastatic bone lesions.
3. Radioactive gold for serous surface tumor implants, and for interstitial administration.
4. Radioactive strontium for beta-ray application to eye lesions.
5. Radioactive cobalt in various types of applicators.

The general rationale of radioactive isotopes for therapy will also be discussed.

COURSE 205

Room 955W **Period: Th**

H. M. PARKER, M.Sc., F. Inst. P.
Richland, Washington

Radiation Dosimetry

This is a background course in basic dosimetry principles for all types of ionizing radiations. Topics discussed include (1) the reasons for having chosen an ionization method of dosimetry for roentgen rays, and how this led to the original definition of the "roentgen," (2) development of the Bragg-Gray Principle and how this led to a new definition of the roentgen, and later to the general acceptance of the "absorbed dose" concept, (3) dosimetry with particulate radiations and the introduction of special units such as the "rep" and the "rad," and (4) attempts to factor relative biological effectiveness into dose units, and the use of the term "rem."

COURSE 208

Room 957W **Period: Th**

VINCENT P. COLLINS M.D.
Houston, Texas

Breast Cancer

A basis for the treatment of breast cancer is developed from a concept of the natural history of the disease and the possible influence that treatment may exert. The estimation of the effect of treatment is examined in order to measure and compare the benefit obtained from different treatment policies

which may be intended as curative, prophylactic or palliative. Appropriate techniques of radiotherapy are described.

COURSE 210

Room 905W **Period: Th**

ISADORE MESCHAN, M.D.
BYRON G. BROGDON, M.D.
T. H. ODDIE, D.Sc., F. Inst. P.
Little Rock, Arkansas

Interstitial Cobalt 60 Therapy

The various adjuncts in relation to setting up a program for use of cobalt 60 in interstitial plaque-like, and intracavitary applications will be described. Special equipment will be described which has been employed in this program and an effort will be made to clarify details regarding the procurement of cobalt as well as such matters as special instruments, storage of cobalt, record keeping, and disposal. In addition, a special applicator for the treatment of carcinoma of the cervix, utilizing cobalt 60 will be described and the special tables in relation to all uses of cobalt 60 will be presented.

COURSE 303

Room 908W **Period: Th**

RICHARD SCHATZKI, M.D.
Brookline, Massachusetts

The Lower End of the Esophagus

The instructor will discuss the lower end of the esophagus—in particular esophagitis, hiatus hernia and the lower esophageal ring—what he knows and does not know about these subjects.

COURSE 307

Room 919 **Period: Th**

EUGENE F. VAN EPPS, M.D.
Iowa City, Iowa

Roentgen Evaluation of Respiratory Distress in Infants and Children

Respiratory difficulty with or without cyanosis, stridor or coughing is common in infants and children. The causes of such symptoms are protean and encompass many organ systems. Correlation of symptoms and signs with the roentgenographic findings will be given.

COURSE 311

Room 920 **Period: Th**

A. S. MACMILLAN, M.D.
Boston, Massachusetts

Film Reading Session

3. *The film reading session* will consider conditions met in a hospital devoted to treatment of the sinuses, mastoids and abnormalities of the esophagus. Rare and unusual conditions are often emphasized in a presentation such as this, with failure to give adequate consideration to the more common types of pathology met with every day. This discussion will deal with the more commonly encountered abnormalities in which roentgenologic assistance is sought.

COURSE 313

Room 941W **Period: Th**

PAUL A. RIEMENSCHNEIDER, M.D.
Portsmouth, Virginia

Cerebral Angiography

A review dealing with the indications, techniques, hazards and usefulness of cerebral angiography. Films will be shown to demonstrate the displacement patterns caused by intracranial space-occupying lesions in various areas. In addition to the gross displacement of anterior and middle cerebral arteries, emphasis will be placed on the information to be gained from observation of other constant arteries and the deep venous system.

COURSE 420A

Room 910W **Period: Th**

LESTER W. PAUL, M.D.
Madison, Wisconsin

Principles of Interpretation of Chest Roentgenograms

The Normal Chest and Variations

This part of the course will be devoted to a discussion of the structures visualized in chest roentgenograms including the anatomy of the mediastinum; the recognition of early lymph node enlargement; the hili, anatomical differences and variations; the roentgen visualization of the pulmonary arteries and veins and the influence of the cardiovascular system on the appearance of the lung fields; the anatomy of the pulmonary apex and its variations. Some of the puzzling shadows encountered in apparently normal chests will be considered. Emphasis will be placed not only upon the identification of normal structures but also on the recognition of the early changes caused by various diseases.

COURSE 406A
and
COURSE 406B

Room 944W Periods: Th F

(Sequential Course—2 Periods)

CHARLES T. DOTTER, M.D.
Portland, Oregon

Angiocardiography

The course (divided into two periods) comprises a general presentation of angiocardiographic technique, indications, and results. The second period will be concerned primarily with congenital cardiac disease. Those attending are urged to bring slides or films of instructive or unusual angiocardiograms.

COURSE 104

Room 917 Period: F

CHARLES A. OWEN, M.D.
Rochester, Minnesota

Diagnostic Use of Radioisotopes

A. Metabolic function tests: I^{131} and I^{132} for the measurement of thyroidal uptake, iodide clearance, and radiothyroxine production. TSH/I^{131} test of pituitary function. Radio-electrolytes (Na^{24} and K^{42}) in adrenal disease. Ca^{45} and P^{32} in parathyroid disease. Cu^{64} in Wilson's disease.

B. Hematology: Blood volume determinations with I^{131}-albumin or with Cr^{51}-labeled erythrocytes or plasma proteins. Red cell survival with Cr^{51} and Fe^{59}. Iron metabolism and hemachromatosis using Fe^{59}. Co^{60}-vitamin B_{12} in the evaluation of pernicious anemia, an intrinsic factor.

C. Gastroenterology: quantitation of intestinal bleeding with Cr^{51}; liver function test (I^{131}-rose bengal); pancreatic function (I^{131}-albumin).

D. Tumor localization (I^{131}, I^{131}-albumin, P^{32}, etc.)

E. Miscellaneous.

COURSE 202

Room 905W Period: F

WILLIAM T. MOSS, M.D.
Chicago, Illinois

Clinical Physiological Responses of Normal Tissues to Localized Irradiation

The effects of local irradiation are those of selective destruction and fibrotic repair. The pathological physiology subsequent to these irradiation induced acute changes and the reparative processes are often of vital importance in determining indications and techniques of therapy. Some of the more significant and interesting changes will be discussed. Included will be the early and late physiological changes following irradiation of the lungs, kidneys, bowel, stomach and endocrine organs.

COURSE 206

Room 955W Period: F

CHARLES L. MARTIN, M.D.
Dallas, Texas

Low Intensity Radium Needles

Implanted low intensity radium needles provide the simplest and most efficient method available for administering short wave irradiation to accessible carcinomas. Dosage calculations and implantation techniques will be discussed and many slides illustrating the results obtained in carcinoma of the face, lip, mouth, oropharynx, and uterine cervix will be presented. A combined roentgen-ray and radium needle technique which has been used successfully in the treatment of metastatic cervical lymph nodes will also be demonstrated.

COURSE 302

Room 957W Period: F

ARTHUR S. TUCKER, M.D.
Cleveland, Ohio

Discography and Myelography

The techniques of both discography and myelography will be presented. Cases must be studied individually, and specialized attention given to each patient. The differential diagnosis of intradural and extradural lesions will be discussed. Complete obstructions of the spinal canal are usually due to tumors, but arachnoiditis, hemorrhage, infection, trauma, congenital malformations, and protruded discs may produce similar blocks. Intramedullary lesions are much less common than extramedullary.

Discography is an easy, safe and reliable procedure for use in the diagnosis of protruded intervertebral discs. For technical reasons application of the procedure is limited to the lower lumbar spine where most protrusions occur. In patients where the clinical findings point to lesions higher in the spinal column, myelography is indicated.

COURSE 304

Room 908W Period: F

J. MAURICE ROBINSON, M.D.
San Francisco, California

Polyps of the Colon

In this course an attempt will be made to evaluate the relative merits of fluoroscopy, fluoroscopic image ("Fluorex"), intensification, high voltage roentgenography, "spot films," siphonage, evacuation studies, thin barium suspensions, special barium suspensions, methods of bowel preparation, double contrast techniques, etc., in the demonstration of polyps of the large bowel.

A "single contrast" barium enema study is advocated which seems to be generally superior to the double contrast study as the primary means of detecting polyps and, because it is also employed in routine barium enema examinations, will result in a

gratifying harvest of unsuspected asymptomatic polyps.

The inevitable pitfalls which await the unwary one who relies too greatly on any single approach on any given day, however, are sadly stressed.

COURSE 308

Room 919 **Period: F**

GEORGE COOPER, Jr., M.D.
Charlottesville, Virginia

The Collagen Diseases: A Clinical, Roentgenological, and Pathological Correlation

The roentgenological findings in scleroderma, disseminated lupus erythematosus and polyarteritis are now well established and numerous, but often nonspecific and confusing. Accurate diagnosis usually depends upon close cooperation between internist, radiologist, and dermatologist. It is therefore important that the radiologist have a working understanding of the clinical manifestations and pathology of these diseases.

Dermatomyositis and several other conditions considered to belong in the collagen disease group will also be briefly considered.

COURSE 312

Room 920 **Period: F**

CLYDE A. STEVENSON, M.D.
Temple, Texas

Fluorosis

The radiologist should play an important role in his community in regard to the problem of fluoridation of drinking water. Until recently, very little has been known about the medical effects of ingested fluorides. The roentgenologic and clinical findings have been mainly concerned with exposure to excessive fluorides in industry.

This instruction course will bring the radiologist up to date in regard to the general problems of fluorosis, with emphasis on dental, clinical and roentgenologic findings in patients who have drunk fluoride-containing water over a long period of time.

A printed syllabus will be furnished each registrant.

COURSE 314

Room 942W **Period: F**

PATRICK RILEY, M.D.
Chicago, Illinois

The Dynamic Approach to the Roentgenologic Diagnosis of Shunts and Valvular Lesions of the Heart

Shunts and valvular lesions produce their effects upon the heart by altering the flow and pressure of circulating blood. These dynamic changes are selective and are dependent upon the nature and location of the responsible anatomic lesion. They express themselves at roentgenologic examination as selective changes in size of the heart chambers and great vessels (more especially the main stem pulmonary artery and its intrapulmonary branches).

Roentgenologic analysis aimed at a precise diagnosis, then, resolves itself not into memorizing traditional, sometimes misleading, configurations but into precise demonstration of selective changes in size of chambers and vessels. This concept makes it necessary to see each chamber and vessel free of superimposition.

Such a method of filming and analysis will be presented, illustrating the critical importance of right ventricular enlargement and dynamic distention of the pulmonary artery in left-to-right shunts and mitral stenosis, and, further, that such evaluation is most critically done on lateral projections. Common pitfalls will be illustrated.

Roentgen signs will be correlated with data obtained at cardiac catheterization, surgery and autopsy in a series of adult patients with shunts and valvular lesions.

COURSE 402B

Room 910W **Period: F**

LESTER W. PAUL, M.D.
Madison, Wisconsin

Principles of Interpretation of Chest Roentgenograms

The Abnormal Chest

As a continuation of the first part of the course this period will be given over to a consideration of a variety of disease processes affecting the lungs, pleura and mediastinum. Included will be a discussion of the roentgenology of pulmonary edema and congestion, the early signs of edema; diseases causing generalized changes in the lungs essentially interstitial in character; bronchial occlusion, the mechanics of production and roentgen patterns; atelectasis, variations in appearance, linear atelectasis, the right middle lobe syndrome; pleural effusions, atypical manifestations, etc.

COURSE 404C

Room 941W **Period: F**

HAROLD O. PETERSON, M.D.
St. Paul, Minnesota

Normal and Abnormal Cerebral Pneumography

Encephalography and ventriculography will be considered together. There will be no discussion on technique other than to illustrate the positions used in the routine examination. Minimum essentials of neuroanatomy will be stressed. Confusing patterns which occur frequently and are actually normal will be illustrated and explained. There will be a few general remarks on atrophic lesions. The fundamental deformities and displacements caused by masses will be shown and discussed.

CONDENSED SCHEDULE OF COURSES ON TUESDAY, SEPT. 20, 1955

Code: T **3:00–4:30 P.M.** **Code: T**

Therapeutic Radiology, Nuclear Medicine, Radiation Physics		Diagnostic Roentgenology	
201—Van Herick Fricke Room 905W	The Treatment of Carcinoma of the Cervix Uteri	**401A—Templeton Room 908W**	Roentgenology of the Pharynx and Esophagus
		403A—Hope Room 919	Problems in Pediatric Roentgenology
203—Williams Borrman Room 955W	The Thorough Calibration of an X-ray Machine	**404A—Peterson Room 941W**	The Normal Skull
		405A—Miller Room 942W	Roentgenologic Cardiology: Acquired Abnormalities
207—Evans Room 957W	Radiation Biology	**305—Zariquiey Campeti Room 910W**	Bronchopulmonary Segment as a Functional Unit
		309—Macmillan Room 920	Roentgen Examination of Sinuses
101—Aebersold Room 917	Recommendations on Training and Facilities for Nuclear Medicine	**315—Marshak Room 944W**	Roentgen Diagnosis of Nonmalignant Lesions of Small Intestine
		317—Snow Room 959W	Roentgenology in Obstetrics

CONDENSED SCHEDULE OF COURSES ON WEDNESDAY, SEPT. 21, 1955

Code: W **3:00–4:30 P.M.** **Code: W**

Therapeutic Radiology, Nuclear Medicine, Radiation Physics		Diagnostic Roentgenology	
204—Quimby Kligerman Room 955W	Practical Clinical Techniques in Rotation Therapy	**410B—Templeton Room 908W**	Roentgenology of the Pharynx and Esophagus
		403B—Hope Room 919	Problems in Pediatric Roentgenology
209—Eberhard Room 957W	Treatment of Malignant Tumors of the Skin	**404B—Peterson Room 941W**	The Abnormal Skull
		405B—Miller Room 942W	Roentgenologic Cardiology: Congenital Abnormalities
211—Vermund Stenstrom Room 959W	Radiation Effects on Malignant Tumors	**301—Rose Friedell Room 905W**	Microfilming Roentgenograms for Filing Purposes
		306—Figley Room 910W	Splenoportography
102—Evans Room 917	The Scope of Nuclear Medicine	**310—Macmillan Room 920**	Roentgen Examination of the Mastoids
		316—L. C. Collins Room 944W	Problems of Bone Interpretation in Children

CONDENSED SCHEDULE OF COURSES ON THURSDAY, SEPT. 22, 1955

Code: Th **3:00–4:30 P.M.** **Code: Th**

Therapeutic Radiology, Nuclear Medicine, Radiation Physics		Diagnostic Roentgenology	
205—Parker Room 955W	Radiation Dosimetry	**420A—Paul Room 910W**	Principles of Interpretation of Chest Roentgenograms
		405C—Miller 942W	Roentgenologic Cardiology: "Quiz Session"
208—V. P. Collins Room 957W	Breast Cancer	**406A—Dotter Room 944W**	Angiocardiography. Part I
		303—Schatzki Room 908W	End of the Lower Esophagus
210—Meschan Brogdon Oddie Room 905W	Interstitial Cobalt 60 Therapy	**307—Van Epps Room 919**	Roentgen Evaluation of Respiratory Distress in Infants and Children
		311—Macmillan Room 920	Film Reading Session
103—Friedell Room 917	Nuclear Medicine: Therapeutic Applications	**313—Riemenschneider Room 941W**	Cerebral Angiography

CONDENSED SCHEDULE OF COURSES ON FRIDAY, SEPT. 23, 1955

Code: F **1:30–3:00 P.M.** **Code: F**

Therapeutic Radiology, Nuclear Medicine, Radiation Physics		Diagnostic Roentgenology	
202—Moss Room 905W	Clinical Physiological Responses of Normal Tissues to Localized Irradiation	**402B—Paul Room 910W**	Principles of Interpretation of Chest Roentgenograms
		404C—Peterson Room 941W	Normal and Abnormal Cerebral Pneumography
206—Martin Room 955W	Low Intensity Radium Needles	**406B—Dotter Room 944W**	Angiocardiography: Part II
		302—Tucker Room 957W	Discography and Myelography
104—Owen Room 917	Diagnostic Use of Radioisotopes	**304—Robinson Room 908W**	Polyps of the Colon
		308—Cooper Room 919	The Collagen Diseases
		312—Stevenson Room 920	Fluorosis
		314—Riley Room 942W	Roentgenologic Diagnosis of Shunts and Valvular Lesions of Heart

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS*

ARIZONA RADIOLOGICAL SOCIETY

The following officers of the Arizona Radiological Society have recently been elected for the ensuing year of 1955–1956: *President*, Dr. R. Lee Foster, Phoenix; *Vice President*, Dr. John Wilson, Tucson; *Secretary-Treasurer*, Dr. James J. Riordan, 550 W. Thomas Road, Phoenix, Arizona.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY

At the meeting of the Connecticut Valley Radiologic Society held on April 22, 1955, the following officers were elected for the coming year: *President*, Dr. Elmer Harrington, Holyoke, Massachusetts; *Vice President*, Dr. Edward Bennett, Hartford, Connecticut; *Secretary-Treasurer*, Dr. Thomas Crowe, 53 Center Street, Northampton, Massachusetts.

SECTION ON RADIOLOGY, CONNECTICUT STATE MEDICAL SOCIETY

At the annual meeting of the Section on Radiology of the Connecticut State Medical Society which was held on Thursday, June 9, 1955, Dr. William G. H. Dobbs, Torrington, Connecticut, was elected *President*, and Dr. John Burbank, Meriden Hospital, Meriden, Connecticut, was elected *Secretary-Treasurer*.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA

At the May, 1955, meeting of the Radiological Society of Southern California, the following officers were elected for the year 1955–1956, to take office in June, 1955: *Chairman*, Dr. Lowell S. Goin, Los Angeles; *Vice-Chairman*, Dr. John D. Camp, Los Angeles; *Secretary-Treasurer*, Dr. James B. Irwin, 1831 Fourth Avenue, San Diego, California.

SOCIEDAD DE RADIOLOGÍA, CANCEROLOGÍA Y FÍSICA MÉDICA DEL URUGUAY

At a recent meeting of the Sociedad de Radiología, Cancerología y Física Médica del Uruguay the following officers were elected for the year 1955–1956: *President*, Dr. Héctor Bazzano; *Vice President*, Dr. Luis A. Vasquez Piera; *Secretary General*, Dr. Roberto Francois; *Acting Secretary*, Dr. Ricardo Parada, Agraciada 1464, Piso 13, Montevideo, Uruguay; *Treasurer*, Dr. Enrique Capandegui.

SOUTH CAROLINA RADIOLOGICAL SOCIETY

At the regular spring meeting (1955) of the South Carolina Radiological Society the following officers were elected for the coming year: *President*, Dr. George Smith, Columbia; *Vice President*, Dr. Willis Hood, Greenville; *Secretary-Treasurer*, Dr. Samuel Lippincott, 103 Rutledge Avenue, Charleston, South Carolina.

INDIAN RADIOLOGICAL ASSOCIATION

At the Annual General Meeting of the Indian Radiological Association, held in Lucknow in February, 1955, Dr. Ross Golden, Visiting Professor of Radiology, School of Medicine, University of California Medical Center, Los Angeles, was unanimously elected the sixth Sir Jagadish Bose Memorial Lecturer for the current year and awarded the Gold Medal for his outstanding contributions to the science of radiology.

GRANTS IN RADIOLOGICAL RESEARCH

The James Picker Foundation has announced the award of eleven Grants, three Fellowships, and one Grant for Scholar in Radiological Research for the year 1955–1956. These awards, totaling approximately $62,000, were made on recommendation of the Committee on Radiology of the National Academy of Sciences-National Research Council.

The Picker Foundation was established in 1947, with the objective of fostering research in and broadening the scope of radiology. With the cooperation of the Academy-Research Council, the Foundation initiated its program

* The list of Meetings of Radiological Societies appears in the July, 1955, issue of the JOURNAL, and will be published in the September number.

of research grants and followships in 1950. Since that time, including the awards mentioned above, grants have been made in support of investigations in fourteen laboratories in this country, three in Canada, and four in institutions abroad. Additional grants have been made for support of two Scholars in Radiological Research, and Fellowships have been awarded to seven young scientists to enable them to advance their preparation for investigative careers in the field of radiology. Of the fellows, four were United States citizens, one of whom studied abroad. The remaining three fellows were citizens of South Africa, Sweden, and India who came to this country or Canada for study.

APPLICATIONS FOR GRANTS IN CANCER RESEARCH

Acting for the American Cancer Society, the Committee on Growth of the National Academy of Sciences-Research Council is accepting applications for grants-in-aid for cancer research in the United States. Applications received before October 1, 1955, will be considered during the winter and grants recommended at that time become effective on July 1, 1956. *Investigators now receiving support will be notified regarding application for renewal.*

The Committee feels that an understanding of cancer depends upon a deeper insight into the nature of the growth process, normal and malignant. Therefore, the scope of the research program is broad and includes, in addition to clinical investigations on cancer, fundamental studies in the fields of cellular physiology, morphogenesis, genetics, virology, biochemistry, metabolism, nutrition, cytochemistry, physics, radiobiology, chemotherapy, endocrinology and carcinogenesis. The Committee is particularly interested in encouraging research in the epidemiology of cancer.

Application blanks may be obtained from the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C.

CONFERENCE ON RARE EARTHS IN BIOCHEMICAL AND MEDICAL RESEARCH

The Oak Ridge Institute of Nuclear Studies will sponsor a conference on Rare Earths in Biochemical and Medical Research at Oak Ridge, Tennessee, October 28–29, 1955. A round-table session on the subject was held at the recent annual meeting of the Federation of American Societies for Experimental Biology. Increasing biochemical and medical interest in the rare-earth elements stems largely from recent basic studies with their radioisotopes. The conference will emphasize chemical, pharmacological, and biochemical problems of the lanthanons and of yttrium, and their possible applications. The program is to be largely by arrangement, but contributed papers will be included where time permits. Titles and abstracts should reach G. C. Kyker, Medical Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee, *before* August 15, 1955. The early publication of a proceedings of the conference is intended.

Vol. 74, No. 2

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Chambers, William R. Hydrocephalus consequent to cranium bifidum; report of a case suggesting a new hypothesis as to one possible cause. *A.M.A. Am. J. Dis. Child.*, Oct., 1954, *88*, 466–470.

In this article a case is presented with progressive enlargement of the head consequent to cranium bifidum which proved to have a hemangioma underlying the cranial defect rather than hydrocephalus. A search was made of the cases handled in the author's clinic and two other babies were discovered whose findings were strongly suggestive of the possibility of such a lesion. Both of these children had a progressively enlarging head circumference.

Hydrocephalus occurring with cranium bifidum is usually considered to be of rather high occurrence. The mechanism of this complication in cranium bifidum has been considered by some as due to congenital atresia of the aqueduct, failure of formation of the foramina of Luschka and Magendie and other associated abnormalities. These are, however, exceedingly rare. The author suggests that in certain cases intracranial exploration may reveal benign tumors associated with cranium bifidum which are either responsible for the progressive enlargement of the heads themselves or else secondarily have blocked the cerebrospinal fluid system and are responsible for hydrocephalus.—*Ralph S. Bromer, M.D.*

French, Lyle A., and Peyton, William T. Vascular malformations in the region of the great vein of Galen. *J. Neurosurg.*, Sept., 1954, *11*, 488–498.

This article deals with arteriovenous shunts in the region of the pineal gland, with communication between one or more of the adjacent arteries and the great vein of Galen. These malformations are often associated with hydrocephalus or subarachnoid hemorrhage, and are usually amenable to surgery. They may be demonstrated by means of cerebral angiography. Both carotid and vertebral angiograms should be obtained. This is to insure filling those lesions with the feeding vessels from the posterior cerebral artery, as well as the more anterior lesions.

A review of 8 cases previously reported is included, and 5 new cases are presented.—*J. R. Hale, M.D.*

Kehler, Walter H., and Beck, Erwin. Cerebellar sarcoma with bone metastases. *Radiology*, Nov., 1954, *63*, 736–740.

There have been only 10 cases reported in the literature of extradural metastases in adults from proved intracranial neoplasms, and only 3 with metastases to bone.

The authors describe a case of cerebellar sarcoma, producing clinical manifestations commonly identified with cerebellar medulloblastoma. The tumor arose in the cerebellar meninges, spread along them, and implanted itself on the dura mater. It invaded the foramina of the skull and was present in the ethmoidal sinuses and cervical lymph nodes. It did not grow in lung or other visceral organs, but had replaced about 50 per cent of the red bone marrow. The circumscribed nature of the primary mass suggested that it had begun as an encapsulated tumor, wherefor early surgical removal might have proved curative.

It is emphasized that cerebellar sarcoma and medulloblastoma are indistinguishable clinically and in response to radiation therapy.—*E. E. Seedorf, M.D.*

Neck and Chest

Bonetta, Camillo. La sindrome atelectasica del lobo medio da adenopatia nell'età infantile. (The middle lobe syndrome from adenopathy during infancy.) *Ann. radiol. diag.*, 1954, *27*, 10–22.

This subject is limited to those cases of hilar adenopathy producing atelectasis of the right middle lobe. Although various diseases are responsible for the enlarged hilar lymph nodes, tuberculosis is the most frequent cause. This syndrome is more common in children under six years of age than in people in the older age group.

The fact that the right middle lobe bronchus is smaller in caliber and forms a 30° angle with the inferior bronchus, and is surrounded by a collar of draining lymph nodes, makes this lobe susceptible to the influence of pressure from lymph node enlargement.

Since the diagnosis must be established by roentgenological methods it is necessary to differentiate this condition from others such as lobar pneumonia, pulmonary abscess, and encapsulated pleural effusion. The standard posteroanterior and lateral projections suffice to locate the area involved, and to show the shape and extent of disease but not its cause.

The author does not believe that bronchography as advocated by Biancalano is either advisable, or necessary, and is a rather difficult procedure to carry out in children. Instead, laminagraphy is recommended since by this method the enlarged lymph nodes and the constricted lumen of the bronchus can best be demonstrated. In addition one may be able to determine whether any disease process is located within the parenchyma of the right middle lobe, or the changes are secondary to bronchial stenosis.

Three cases are reported in this article with accompanying illustrations. All had atelectasis of

several months duration and a positive Mantoux test. Under proper medical care the process became reversible with re-expansion of the right middle lobe. For this reason surgical confirmation became unnecessary.

The author presents convincing evidence that his method of examination as advocated for this syndrome has a great deal of merit.—*Peter E. Russo, M.D.*

Hurwitz, Samuel, and Greenhood, Herbert. Pneumothorax and pneumomediastinum in the newborn infant. *J. Pediat.*, Oct., 1954, *45*, 437–442.

Pneumothorax and/or pneumomediastinum are discussed as complications which may be associated with respiratory distress in the newborn infant. It is suggested that they occur more frequently than reports in the literature would lead one to believe. The following classification of causes is set forth:

1. Disease of the lung
2. Congenital defects
3. Trauma
4. Mechanical obstruction of airways
5. Idiopathic

Two cases are presented. In one, the pneumothorax and pneumomediastinum were thought to be secondary to mechanical obstruction by mucus and responded to repeated aspirations. In the other, they were considered idiopathic and aspiration was not deemed necessary. In both, recovery was complete.

Roentgen examination, including a lateral view, is considered essential for definitive diagnosis. Compensatory emphysema, giant congenital lung cyst and diaphragmatic hernia should be considered in differential diagnosis. Prognosis is largely dependent on the associated lung condition. Prophylaxis consists in avoiding any traumatic procedure in instituting respirations, and careful initial suction. Treatment consists of oxygen, stimulants, antibiotics to prevent infection and aspiration where necessary.—*H. G. Peterson, M.D.*

Liban, E., Shamir, Z., and Schorr, S. Periarteritis nodosa in a nine-month-old infant. *A.M.A. Am. J. Dis. Child.*, Aug., 1954, *88*, 210–215.

In the case of periarteritis nodosa in a girl, nine months old, which is presented in this article, there were some unusual clinical, roentgen and pathological findings. When the disease was fully developed the roentgenograms of the lungs revealed a heart enlarged in all directions; round well-defined shadows scattered in both lung fields, particularly near the right hilus; confluent, patchy and hazy shadows in both lung fields. On fluoroscopic examination no hilar pulsations were noted.

The most interesting feature of the autopsy was the sign of healing of the disease. Most of the vascular lesions were old, fibrotic and acellular. Even the acute lesions which were few and were found only in small arteries showed but a slight degree of edema, fibrinous exudation and cellular infiltration devoid of eosinophils. The lesions were confined predominantly to the lungs and heart.—*Ralph S. Bromer, M.D.*

De Carlo, John, Jr., and Startzman, Henry H., Jr. The roentgen study of the chest in measles. *Radiology*, Dec., 1954, *63*, 849–852.

The authors present the roentgenographic chest findings which they have observed in patients with measles. In 100 cases of which 60 had roentgenograms, the following changes were noted:

1. Localized infiltration
2. Bronchopneumonic infiltration.
3. Large hilar shadows.
4. Intense pulmonary markings.
5. Pleuropulmonary changes.
6. Widened mediastinum.
7. Atelectasis.

Of the above listed changes, localized infiltration and bronchopneumonia were most commonly seen.

It is suggested that the changes noted are probably of virus origin, and pave the way for bacterial invasion of the lungs.—*A. Ralph Watson, M.D.*

Storey, Clifford F., and Marrangoni, Albert G. Lobar agenesis of the lung. *J. Thoracic Surg.*, Nov., 1954, *28*, 536–543.

The authors report what they believe is the first recorded case of lobar agenesis to be diagnosed preoperatively and proved anatomically.

The patient was a twenty-one year old male complaining of chronic cough and dyspnea. Physical examination revealed a decrease in respiratory motion on the involved (left) side, hyperresonance, and decreased breath sounds. Chest roentgenograms revealed increased radiolucency of the left lung field with shift of the mediastinum to the left. Fluoroscopic study showed the mediastinum shifted toward the right on expiration and returned to normal position on inspiration. Bronchograms demonstrated a marked narrowing of the left main stem bronchus and no evidence of a left lower lobe bronchus in spite of good filling. With the preoperative diagnosis of agenesis of the left lower lobe and congenital stenosis of the left main stem bronchus, a left thoracotomy was performed in an effort to resect the stenotic bronchus and anastomose the ends. The bronchial lumen was found to be too small to permit this procedure so a pneumonectomy was done and the diagnosis proved.

A brief summary of the embryological background of the anomaly is given.—*Paul C. Olfelt, M.D.*

KIRCHHOFF, H. W. Die Anwendung der Tomographie bei unklaren Mittelschattenveränderungen im frühen Kindesalter. (Laminagraphy of obscure mediastinal lesions in early childhood.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Oct., 1954, *81*, 431–440.

Laminagraphy is an important aid in the differential diagnosis of mediastinal lesions, especially in cases of enlargement of the thymus versus mediastinal pleurisy. Table 1 indicates the chief differences noted conventionally.

TABLE I

	Thymic Enlargement	Superior Mediastinal Pleurisy
Most common shapes seen in posteroanterior view	cape mound asymmetrical lobulated	dome chimney tent or sail pennant
Borders	rounded obtuse angle merge with right auricle and great vessels	sharp acute angle S-shaped concave
Lateralization	often bilateral	unilateral, right more than left
Lateral view	diffuse, non-homogeneous shadow	homogeneous shadow often ending at the lesser fissure
Fluoroscopic image	change in form with respiration descends with ex- and ascends with inspiration	no change with respiratory phase
Lesser fissure	not visualized	widened and merges with mediastinal pleura
Lung findings	normal	signs of bronchitis or other pathology in right upper lobe

Despite these criteria, differentiation may be difficult. Laminagraphic studies show enlarged lymph nodes in the right superior mediastinum in case of mediastinal pleurisy but none in thymic hyperplasia. An enlarged thymus casts a structureless, homogeneous shadow situated in the anterior and middle but not in the posterior mediastinum. In instances of thymic enlargement, further proof of the diagnosis is found in the response to small doses of roentgen rays or ACTH. These therapeutic modalities do not influence mediastinal pleurisy.

Enlarged lymph nodes may produce shadows simulating cardiac enlargement, thus leading to a false diagnosis of congenital heart disease. Laminagraphic studies quickly dispel this error.

Laminagraphic studies may also indicate the tuberculous nature of enlarged hilar and mediastinal lymph nodes, since small infiltrates in the pulmonary parenchyma are frequently demonstrated in various laminagraphic sections. Typical of early childhood tuberculosis is the isolated involvement of mediastinal lymph nodes, whereas other infections may involve the epibronchial lymph nodes as well as those which parallel the course of the major mediastinal vessels.—*Joseph Zausner, M.D.*,

LEIGH, TED F., ABBOTT, OSLER A., ROGERS, JAMES V., JR., and GAY, BRIT B., JR. Venous aneurysms of the mediastinum. *Radiology*, Nov., 1954, *63*, 696–705.

Some features of aneurysms arising in venous structures of the mediastinum are discussed and 4 cases are presented. An unusual case of congenital aneurysm of the superior vena cava is described, this being the only such case that has been reported. The most striking roentgenologic features in this case were the pliability of the lesion, allowing marked changes in shape with respiration and with positioning of the patient, and the wide excursions with pulsations. Another case of aneurysm of the superior vena cava is presented in which the aneurysm of the superior vena cava is presented in which the aneurysm resulted from an anomaly of the pulmonary venous return and was associated with interatrial septal defect.

Pulmonary venous anomalies may be classified into three major groups: (1) incomplete drainage of the pulmonary veins into the right atrium or its tributaries; (2) complete drainage of all pulmonary veins into the right atrium or its tributaries, not associated with other major anomalies of the cardiovascular structures; and (3) complete drainage of all pulmonary veins into the right atrium or its tributaries, associated with other significant anomalies of the cardiovascular system. The characteristic findings in these cases are broadening of the superior mediastinum bilaterally producing a configuration suggestive of a figure-of-eight and enlargement of the right auricle and ventricle with abnormally small left cardiac chambers. Angiocardiographic examination is diagnostic.

A case of aneurysm of the hemiazygos vein, resulting from a long standing portal hypertension, and a case of aneurysm of the azygos vein, resulting from a congenital anomaly of the heart (cor biloculare and pulmonary stenosis) and hypoplasia of the inferior vena cava, are also presented.—*Harold C. Hamilton, M.D.*

Sobin, Sidney S., Carson, Merl J., Johnson, John L., and Baker, Charles R. Pulmonary valvular stenosis with intact ventricular septum: isolated valvular stenosis and valvular stenosis associated with interatrial shunt. *Am. Heart J.*, Sept., 1954, *48*, 416–432.

Twenty-eight patients with pulmonary valvular stenosis and intact ventricular septum studied at the Children's Hospital, Los Angeles, were divided into two groups according to the absence or presence of an atrial shunt: (1) isolated pulmonary valvular stenosis—12 patients; (2) pulmonary valvular stenosis with patent foramen ovale or atrial septal defect—16 patients.

Roentgen examination of the 12 patients with isolated pulmonic stenosis showed that all had abnormal-sized hearts. In all there were enlargement of the right ventricle, prominence of the pulmonary artery segment, and diminished vascularity in the distal lung fields. Angiocardiography showed slow filling and emptying of the pulmonary vessels and in all but one patient there was a demonstrable filling defect between the outflow tract of the right ventricle and pulmonary artery. Poststenotic dilatation of the pulmonary artery was present in all instances.

In all 16 cases of pulmonary valvular stenosis with atrial septal defect or patent foramen ovale there was roentgenographic evidence of cardiac enlargement, termed "slight to moderate," with enlargement of the right atrium and right ventricle; the left atrium was not enlarged in any patient. The pulmonary artery segment was prominent in all, and distal pulmonary vascularity was decreased in 15 of the 16 patients. Angiocardiography was performed in 12 patients and in each instance it demonstrated slow filling and emptying of the pulmonary arteries. In 11 of the 12 patients a filling defect could be demonstrated between the outflow tract of the right ventricle and the pulmonary artery. Four patients exhibited early filling of the left atrium following filling of the right atrium. Premature opacification of the aorta was not present in any of the 12 subjects. A cardiac catheter could be passed from the right to the left atrium in 7 patients, and in 6 of these at least moderate arterial unsaturation was present. Three of the 4 patients with angiocardiographic evidence of right to left interatrial flow had arterial unsaturation. In the remainder of this group the absence of premature visualization of the aorta by angiocardiography, comparison of right-heart blood-oxygen values, and arterial unsaturation permitted the diagnosis of interatrial shunt.

The roentgenologic features of pulmonary valvular stenosis with intact ventricular septum have been summarized by Humphrey as follows:

There is constant, but variable in degree, enlargement of the right ventricle, often enlargement of the right atrium, and dilatation of the main pulmonary artery with rather marked dilatation of the left pulmonary artery, and a normal or underdeveloped right pulmonary artery. Fluoroscopic examination shows the pulsations over the left hilar and main pulmonary arteries to be normal or somewhat increased while those in the right hilar pulmonary artery are diminished. Peripheral pulmonary vasculature is decreased, indicating decreased pulmonary blood flow. Fluoroscopy of the lung parenchyma is usually unsatisfactory for evaluation of vascularity, and careful roentgenographic examination is the only basis for unbiased opinion. The typical diagnostic angiocardiogram shows slow filling and emptying of the pulmonary arteries, persistent visualization of the right ventricle (increased transit time), thickened right ventricular wall, dilatation of the main and left hilar pulmonary arteries, a small right hilar pulmonary artery, and a filling defect at the pulmonary valve area. In rare instances, the thin streaming jet of dye can be seen passing through the stenotic valve. The presence of an interatrial shunt permits early opacification of the left atrium, followed by visualization of the left ventricle and aorta.—*Harold Fulton, M.D.*

Hyman, Julian B., and Epstein, Frederick H. A study of the correlation between roentgenographic and post-mortem calcification of the aorta. *Am. Heart J.*, Oct., 1954, *48*, 540–543.

In a study of the prevalence of atherosclerosis in a random sample (568 individuals) of a working population over forty years of age, roentgenograms of the thoracic and abdominal aorta showed calcification in 26 per cent of the males and 23 per cent of the females. To test the accuracy of roentgen detection of aortic atherosclerosis, roentgenograms and corresponding specimens of the thoracic (72 cases) and abdominal aorta (55 cases) of another group of patients were studied.

Eighteen cases had roentgenographic evidence of calcification of the thoracic aorta and all were verified at postmortem study. Five cases were classified as questionable and no calcification was demonstrated pathologically in these. In addition, 4 cases failing to show roentgenographic evidence of aortic calcification were found to have calcification of the aorta on pathologic examination.

Twenty cases were diagnosed as having calcification of the abdominal aorta on roentgenograms, and 4 were considered to have questionable evidence—all of these 24 cases were found to have calcification of the abdominal aorta at postmortem examination. In 5 cases, pathologically demonstrable calcifications were not demonstrated roentgenographically.

In over 80 per cent of the cases in which calcification of the aorta was present on postmortem examination, the atherosclerotic lesions of the aorta were

advanced, while only 10 per cent of the cases without postmortem evidence of calcification had advanced atherosclerotic lesions, demonstrating that the presence of calcification usually indicates advanced disease.

It is concluded that roentgenographic demonstration of aortic calcification (thoracic or abdominal) is an accurate method for the diagnosis of aortic atherosclerosis. It usually indicates an advanced degree of atherosclerosis. Although advanced atheromata are frequently overlooked by this method, a false-positive diagnosis is not likely.—*Harold Fulton, M.D.*

Miceli, Roberto. Contributo radiologico allo studio dei diverticoli del pericardio. (Roentgenological contribution to the study of pericardial diverticula.) *Ann. radiol. diag.*, 1954, *27*, 23–36.

The first roentgenological observations on pericardial diverticulum were made by Kienböck and Weiss in 1929. Since that time about 56 cases have been reported in the literature. The difference between a pericardial diverticulum and a pericardial cyst is that in the latter the fluid within the cyst does not communicate with the pericardial cavity and the fluid is under tension. With the use of laminagraphy, kymography, pneumomediastinum and angiocardiography, mediastinal structures can be visualized in more detail and this permits a more accurate diagnosis of diseases in this part of the chest.

The author reports a single case of a pericardial diverticulum occurring in a thirteen year old patient. Posteroanterior chest films taken in deep inspiration and full expiration showed a soft tissue mass, smooth in outline, in the right cardiophrenic area. The lateral roentgenogram revealed this mass, semicircular in outline, to be just above the right diaphragm and superimposed on the heart shadow. Laminagraphy clearly showed that the mass was less opaque than the heart shadow. A kymogram demonstrated a pulsation of this mass synchronous with that of the atrium. This pulsation was also observed during fluoroscopic examination.

Yansson's phenomenon is quoted, stating that in inspiration a pericardial cyst becomes elongated and re-assumes its rounded form on expiration.

In the differential diagnosis one must consider the following lesions: (1) *pericardium:* chronic encapsulated pericardial effusion, dermoid cyst, echinococcus cysts and pericardial tumors; (2) *heart:* herniations of the heart muscle, enlargement of the auricular appendage of the right atrium and tumors of the heart; (3) *large vessels:* aneurysm of the ascending arch of the aorta or pulmonary artery; (4) *mediastinum:* benign tumors (fibroma, myxoma, chondroma, leiomyoma), neurofibroma and tumors of lymph nodes; (5) *lungs:* bronchogenic carcinoma; (6) *pleura:* encapsulated pleural effusion, either interlobar or pleuro-mediastinal; (7) *spine:* paravertebral abscess.

The author concludes that by utilizing all the methods available a roentgenological diagnosis of a pericardial diverticulum or cyst can be made to the exclusion of other conditions which may present similar findings on routine roentgenograms.—*Peter E. Russo, M.D.*

Huggins, Charles, and Dao, Thomas L-Y. Characteristics of adrenal-dependent mammary cancers. *Ann. Surg.*, Oct., 1954, *140*, 497–501.

Bilateral adrenalectomy was performed on a series of 100 unselected cases of recurrent far advanced cancer of the breast, from 1951 to 1953. All of the cases had previously failed to respond to roentgen and hormonal therapy. The operative mortality was 5 per cent. Fifty-five cases showed no improvement, 38 cases showed remissions of varying duration and in some cases profound regression of the cancer has persisted for more than three years.

The 100 cases were analyzed regarding: (1) Age at the time of adrenalectomy; (2) interval between mastectomy and appearance of metastases; (3) histopathologic type of primary cancer; and (4) estrogen excretion in the urine. The best response to adrenalectomy occurred: (1) Between the ages of forty and sixty-five years. The prognosis was grave in women under the age of forty; (2) in those cases in which the time interval between mastectomy and the appearance of metastases was greater; (3) in cases with the neoplastic cell type being predominantly adenocarcinoma. This tumor is composed of spheroids with the malignant acini having a lumen lined with one layer of cells, and (4) in those cases with a high titer of estrogens in the urine.

The response to adrenalectomy cannot always be predicted due to so many variables. Some cases with a less differentiated tumor than the adenocarcinoma responded.

The authors use the above criteria to help in the selection of patients for adrenalectomy. Two other tests are mentioned as being useful in selecting patients who would respond better: (1) Increased secretion of calcium in the urine following administration of estrogens in patients with osseous metastases, and (2) patients who have obtained a remission following oophorectomy.—*Charles W. Cooley, M.D.*

Galante, Maurice, Rukes, J. Max, Forsham, Peter H., Wood, David A., and Bell, H. Glenn. Bilateral adrenalectomy for advanced carcinoma of the breast with preliminary observations on the effect of the liver on the metabolism of adrenal cortical steroids. *Ann. Surg.*, Oct., 1954, *140*, 502–518.

Adrenalectomy and oophorectomy were performed on 31 unselected cases of advanced metastatic carcinoma of the breast in which roentgen and hormonal

therapy failed to arrest the disease process. The ages were from twenty-eight to seventy-two years. The criteria used for bilateral adrenalectomy and oophorectomy were: (1) objective evidence of metastases, (2) symptoms referable to metastatic lesions, (3) other forms of therapy having failed, (4) no selection according to the histopathological pattern.

Analysis of the 31 cases showed that there were 2 postoperative deaths, 10 patients eventually died, 19 were still living, objective improvement was noted in 7 and subjective improvement occurred in 14, or 45 per cent, of the cases. The patients have been followed from two to twenty-five months. Metastatic progression of the disease was the cause of death in all but 1 of the 10 cases, in which death was due to an acute adrenal cortical insufficiency. This case had an adenocarcinoma and had excellent subjective and objective response. Histopathologic examination of the cases of the group that died showed 6 undifferentiated carcinomas, 2 adenocarcinomas, and 2 duct carcinomas. In the 19 surviving cases there were 8 undifferentiated carcinomas, 4 duct carcinomas, 1 adenocarcinoma, and 1 infiltrating carcinoma. The others could not be classified. It was suggested from the above data that therapy was less successful in the undifferentiated types of carcinoma in terms of survival.

Objective improvement occurred in 4 of 20 cases with bone metastases, 5 of 9 cases with skin metastases, 1 of 5 cases with lung metastases, 1 of 3 cases with a pleural effusion, and in 1 case of intracranial metastases. Subjective improvement may occur even when there is objective progression of the disease. Bone pain may decrease within twenty-four hours after surgery. Cessation of cough and hemoptysis from lung metastases occurred. Subjective improvement was invariably accompanied by the appearance of "hot flashes." Those who did not have "hot flashes" usually did not show improvement. Cases that responded previously to androgens also did better than those who did not.

A preliminary observation of the results of bilateral oophorectomy, right adrenalectomy and anastomosing of the left adrenal vein to the splenic vein after the spleen had been removed showed that there was no appreciable amount of estrogens in the urine following the operation and that the adrenal cortical function gradually returned to normal. The rationale is that the liver inactivates the estrogens.

The authors conclude that: (1) Bilateral adrenalectomy and oophorectomy is of value in cases that fail to respond to the usual form of therapy, as 45 per cent of the cases showed improvement subjectively and 22 per cent objectively. The method, however, is only a palliative procedure. (2) There is no correlation between clinical improvement and the histopathology of the primary lesion, although the best results so far are in 2 cases of adenocarcinoma. (3) The weight of the adrenal glands, their functional reserve and surgical result on metabolism showed no correlation, and (4) an experimental procedure of bilateral oophorectomy and right adrenalectomy followed later by anastomosis of the adrenal vein to the splenic vein showed marked diminution in the 17-ketosteroids and the estrogens appeared to be essentially absent in the urine. The urinary excretion of hydrocortisone-like substances was found to be unchanged.—*Charles W. Cooley, M.D.*

Cade, Stanford. Adrenalectomy for breast cancer. *Brit. M. J.*, Jan. 1, 1955, *1*, 1–5.

The author states that bilateral adrenalectomy is indicated in the presence of disseminated breast cancer. His series includes 69 patients, in 56 of whom the cancer was far advanced.

All patients are thoroughly examined. Transfusions are given when necessary and patients are placed on cortisone acetate, 100 mg. intramuscularly, forty-eight, twenty-four and one hour prior to surgery.

On the first postoperative day, 100 mg. of cortisone is given intramuscularly every six hours; 50 mg. every six hours on the second day; 25 mg. by mouth every six hours for the next two days until a maintenance dose of 25 mg. daily is reached. Noradeline is used only as an emergency measure in medullary failure.

Bilateral oophorectomy and unilateral adrenalectomy is done first and a week or so later the remaining adrenal is removed.

The operative mortality was 13.6 per cent. There were 12 patients who derived no benefit. There were 14 patients who were symptomatically improved without any change in the metastatic appearance. There were 13 patients who responded very well with relief of symptoms and regression of known metastatic disease.

The longest survival was twenty-four months and the shortest was six weeks. Improvement should occur within the first few postoperative days, and if this is not apparent at the end of a week the case is probably going to be a failure.

The author concludes that subjective and objective improvement may be expected in a small percentage of cases. Illustrations showing regression of skeletal and soft tissue lesions accompany the article.—*Frederick W. O'Brien, Jr., M.D.*

Small, Robert G., and Dutton, Arthur M. Survival of patients with carcinoma of the breast. *J.A.M.A.*, Jan. 15, 1955, *157*, 216–219.

The authors analyze 1,008 cases of histopathologically proved cancer of the breast occurring in the female. Complete survival curves are given, and a comparison is made between patients radically treated and those less radically treated. Comparison is also made according to age groups.

All patients are included who were received for treatment and the follow-up is 100 per cent.

The patients are divided into two groups: those having had radical mastectomy and those having had lesser procedures such as simple mastectomy, irradiation and hormones. In the first group are 738 patients; 293 of these are living, which is 38 per cent, and 445 are known to be dead. There are 270 patients in the second group of whom 44 are living, which is 17 per cent, and 226 are dead.

A review of the charts according to age groups seems to indicate that the mortality is greater in the younger age group. This is true whether the patient had the radical procedure or the more conservative treatment.—*Frederick W. O'Brien, Jr., M.D.*

Abdomen

Glenn, Frank, Evans, John, Hill, Malcolm, and McClenahan, John. Intravenous cholangiography. *Ann. Surg.*, Oct., 1954, *140*, 600–614.

Cholografin is a new agent that can be used intravenously to demonstrate the bile ducts and the gallbladder. Cholografin is a 20 per cent solution of the di-sodium salt of N,N¹-adipyl-bis-(3-amino-2,4,6,-triiodo)-benzoic acid. Ninety per cent of it is excreted by the liver and 10 per cent by the kidneys in normal individuals within ninety minutes after injection.

Hyperthyroidism or known iodine idiosyncrasy are contraindications to its use. Theoretically there is a risk in patients with chronic liver disease, but no reports have been published on its effects on the human liver and no hepatotoxic properties have been noticed.

Cholografin is packaged in 2 ampules of 20 cc. each and a 1 cc. vial for testing sensitivity. If the skin test is negative, the remaining portion of the 1 cc. is given intravenously. If no toxic reaction occurs, 20 to 40 cc. is injected intravenously; 40 cc. is preferable and produces better cholangiograms. Toxic reactions are kept to a minimum if the injection is made slowly over a period of five to ten minutes. Toxic reactions consist of nausea, vomiting, abdominal pain, flushing, and dyspnea. In 88 administrations of chlolografin in 80 cases, there was 1 positive skin reaction in a four month old baby, 2 severe toxic reactions, and 31 transient reactions. No venous thromboses developed.

Roentgenograms are made at fifteen and twenty minutes following the injection and these govern the taking of additional roentgenograms. The bile ducts are visible from ten to sixty minutes following the injection and then gradually fade. The gallbladder begins to opacify in fifty minutes and increases in density for two hours. A fatty meal may be given and roentgenograms made in thirty minutes. Morphine sulphate may be given to produce a spasm of the sphincter of Oddi and thus give a longer observation time. Fluoroscopy and spot roentgenograms may be used. Laminography is of value. A barium meal may be combined with the test.

Cholografin was administered 88 times to 80 cases. The ages varied from nine to eighty-four years. Some normal cases were included. The common duct was demonstrated in 53 of the 80 cases, or 66.2 per cent. It was never visualized in the presence of jaundice, but it was shown in 4 of 8 cases with laboratory evidence of liver damage. The common duct was visualized in 24 of 30 cases who had cholecystectomies. Four of the 6 cases not visualized were jaundiced, 1 had laboratory evidence of liver damage, and the other case had two surgical explorations of the common duct.

The gallbladder visualized in 30 of the 50 cases who did not have a cholecystectomy. These results are not accurate as the examination was terminated in some cases when the common duct was visualized. Calculi were seen in 14 cases. Layering of the contrast medium in the gallbladder occurred occasionally and eventually diffusion took place.

The authors conclude that cholografin is of value: (1) to demonstrate common duct calculi and residual duct stump in postcholecystectomy syndromes; (2) to demonstrate common duct stones preoperatively, (3) in cases in which oral cholecystography fails or is not feasible, (4) in emergencies to quickly show calculi in the gallbladder, and (5) when a tumor is suspected in the porta hepatis. It may be of value in evaluating liver function or liver failure.

Cholografin has no advantage over conventional oral preparations for routine cholecystography.—*Charles W. Cooley, M.D.*

Ludin, H., and Feine, U. Ausscheidungs-Cholangiographie mit Kompression. (Intravenous cholangiography with compression.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1954, *81*, 314–319.

Compression of the common duct in intravenous cholangiography is advocated in order to obtain better visualization of the biliary ducts by causing stasis of opaque bile in their lumen.

Wooden compression cones of various sizes are used. The patient is placed in the prone position with the right side slightly elevated and a cone of appropriate size in placed in the right hypochondrium, to the right from the midline. The patient is lying on the cone and his weight acts as the compressing force.

The first film is obtained about 25 minutes after injection and the position of the cone is readjusted if necessary, in order to obtain compression of the lower end of the common duct. Further films are exposed at 10–20 minute intervals with slightly different degrees of rotation of the patient. When a good visualization of the biliary ducts is obtained, the cone is removed and further films are taken as quickly as possible, one with the patient prone and

the second erect. A further film is exposed 10 minutes later to visualize the opaque substance entering the duodenum.

Fairly often, on films obtained not later than 20 minutes after injection of cholografin, a filling of the right kidney pelvis was observed. This is presumed to be due to simultaneous compression of the right ureter with stasis of radiopaque urine in the kidney pelvis. Cholografin is excreted to an appreciable extent by the kidneys, mainly immediately after injection, while a fairly high blood concentration is present.

Reproductions of six cholangio-cholecystograms and a drawing of the compression cone are included, as well as 5 references.—*Karol E. Matzinger, M.D.*

Felson, Benjamin, and Levin, Emanuel J. Intramural hematoma of the duodenum; a diagnostic roentgen sign. *Radiology*, Dec., 1954, *63*, 823–831.

Intramural hematoma of the intestine is a condition in which, spontaneously or as a result of trauma, a localized collection of blood extravasates into the subserosal and interstitial tissues of the intestine. The authors report 4 cases, in each of which the duodenum was predominantly affected. Their roentgen findings, similarly to the one previously reported case, are so distinctive that they are thought to be pathognomonic of this condition.

The hematoma in 3 of the 4 cases was directly attributable to a non-penetrating injury to the upper abdomen. The predilection of this lesion for the region of the duodeno-jejunal juncture is attributed to the fixation of this portion of the gut at the ligament of Treitz. The hematoma probably begins in the subserosa, separating the serosa from the muscularis. The resulting tumefaction bulges into the lumen, giving rise to the roentgen signs of an intramural mass. Infiltration of blood or of edema fluid into the mucosa occurs, thickening the valvulae conniventes and producing the enlarged folds seen roentgenographically.

Plain films of the abdomen may show obliteration of the right psoas shadow. The diagnosis is made by performing a gastrointestinal examination. The barium studies show: (1) thickening of the mucosal folds proximal to the involved segment, (2) a sharply marginated intramural mass which widened the lumen of the duodenum. This abnormal segment was usually 10 to 20 cm. in length and involved the descending and transverse portions of the duodenum. (3) The valvulae conniventes in this segment were crowded together producing a coil spring appearance such as is seen in intussusception.

The authors believe that the roentgen demonstration of an intramural mass with a coil spring mucosal pattern overlying it is a pathognomonic sign of this condition.

Other variable findings are: (1) evidence of extrinsic pressure on the greater curvature of the stomach; (2) localized downward compression of the transverse colon; (3) marked obstruction at the site of the hematoma.

Subsequent roentgen studies showed improvement in the findings. Three of the patients underwent surgery, at which time confirmation of the diagnosis was obtained.

The differential diagnosis must include: intramural extra-mucosal neoplasm, an intussuscepting mass, pancreatitis, duodenal infarction, and lymphoma or other malignant tumors.— *Donald N. Dysart, M.D.*

Porcher, Pierre, Simon, Gaston-Claude, and (Mme) Métairie-Simon, Paule. L'intérêt du pneumpéritoine provoqué dans l'examen radiographique des hémopéritoines. (Induced pneumoperitoneum in the roentgenographic examination of hemoperitoneum.) *Presse méd.*, Nov. 24, 1954, *62*, 1614–1617.

There is considerable difficulty, ordinarily, in the clinical diagnosis of hemoperitoneum. When the effusion is smallest and when the symptoms are masked by an added lesion, the diagnosis is obscured. Head trauma, shock, and other associated conditions interfere with the discovery of internal hemorrhage.

Simple roentgenograms of the abdomen may be of great value but they are not always decisive. In these difficult cases, and in these exclusively, the authors have for five years, performed pneumoperitoneum followed by roentgenograms. This procedure simplifies the problem of demonstrating fluid levels in the free peritoneal cavity. The method was of value in 30 cases. Small effusions in the pelvis are particularly difficult to visualize and it is essential that the bladder be empty and that a rectal tube be used whenever necessary. Roentgenograms of the pelvis are made in the frontal, lateral decubitus and slight Trendelenburg positions. In extrauterine pregnancy clots may fill the pelvis and interfere with the demonstration of the fluid levels requiring modifications in centering and positioning.—*Marcy L. Sussman, M.D.*

Kunstadter, Ralph H., and Tulsky, Alex. Diagnostic transabdominal pneumoperitoneum in children. *Am. J. Obst. & Gynec.*, Sept., 1954, *68*, 819–829.

The authors discuss the use of diagnostic transabdominal pneumoperitoneum in children, particularly in the diagnosis of several sex-endocrine disturbances. They have found that this is a safe procedure which can reveal valuable information that otherwise could be obtained only by an exploratory laparotomy.

The technique is described in some detail. Seven cases are presented giving the history and the results of the transabdominal pneumoperitoneum.

The procedure is contraindicated (1) if the patient has an active intraperitoneal inflammatory process, (2) if there is reason to suspect adhesion of the bowel to the parietal peritoneum at the site of the puncture, (3) if the patient has any cardiac and/or respiratory embarrassment, and (4) if a systemic infection is present.—*Howard C. Neucks, M.D.*

Robert, F., and Hoffmann, Th. Zur Frage der Hiatusanomalien und des Kardiarefluxes Kardia-Fornix-Fehlanlagen. (Concerning hiatus anomalies and the cardia reflux in cardia-fornix malformations.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1954, *81*, 255–270.

After presenting the normal anatomy of the lower end of the esophagus, the cardia and the cardiac portion of the stomach, the authors discuss the physiology of this region and state that reflux of gastric contents into the esophagus is never encountered under normal conditions. In cases where a segment of the stomach is situated intrathoracically (for instance, in hiatus hernia) reflux into this intrathoracic segment of the stomach must be clearly distinguished from reflux into the esophagus. Reflux into the esophagus is a finding of real importance. It is likely to occur in cases of developmental malarrangement of cardia and cardiac portion of stomach; in fact, it is an indirect sign of this condition. Other—direct—characteristic features of the malarrangement are high insertion of the esophagus, smallness of the gastric air bubble ("Magenblase"), gaping of the cardia, partial or complete absence of the angle between esophagus and stomach, and consequently straight transition of the esophagus, and of the esophageal folds into the stomach of and the gastric folds.

It is the task of the roentgenologist to establish presence or absence of reflux into the esophagus. Since the reflux may be of very transient nature (a sudden shooting up of gastric contents and immediate return into the stomach), fluoroscopy plays a pre-eminent role. The patient is studied in erect position in the lateral view while bending way forward or while pressing as for defecation, and in Trendelenburg position (45°). Exposure of films may or may not succeed, depending on the length of stay of the barium in the esophagus.

Patients' complaints arousing suspicion of the condition under consideration are: subxiphoid or substernal burning, sometimes radiating into the back, and belching; furthermore the patients may be subject to bleeding (small hematemesis, occult blood) and to secondary anemia. If in these cases the disease is not searched for and not found, the disturbance may be erroneously diagnosed as functional. If the condition is not recognized and not corrected, reflux is liable to cause esophagitis, ulceration, stricture and shrinkage.

The authors include a description of the anatomy as studied surgically: wide hiatus, tenuous wall of the hiatus, high position of cardia, straight-line arrangement of esophagus and stomach and insufficient fixation in these regions.

For early cases the authors quote a comparatively simple abdominal operation; *i.e.*, reducing the size of the hiatus and constructing the normal esophagus-stomach-angle through esophagocardiogastropexy.

The relation of the disease in question to various degrees of hiatus hernia is pointed out by a table of symptoms and signs and by a diagram. The two conditions have certain resemblances; the main difference between them is displacement of some gastric segment into the thoracic cage present in hernia and absent in the condition under consideration.

Twenty-five cases were observed, 16 of which were operated on. Two typical cases are described with surgical correction. No recurrence occurred in the first case within two years postoperatively, while in the second case a recurrence followed an accident one year postoperatively. There are 11 roentgenographic reproductions and a tabulation of 15 cases.—*S. W. Westing, M.D.*

Beck, Hans R. Beitrag zur Röntgenologie der Hiatushernie und der Hiatusinsuffizienz. (Contribution to the roentgenology of hiatus hernia and of hiatus insufficiency.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1954, *81*, 276–283.

Hiatus insufficiency connotes a predisposition to hiatus hernia. The term is the result of a compromise of various authors abroad in borderline cases of hiatus hernia. The author now tries to clarify a few unsettled questions of the terminology.

In recent years three different types of hiatus hernia have been described in Europe as follows: (1) congenital type with short esophagus—a rare form, (2) paraesophageal type and (3) axial type with tortuous esophagus. Hiatus insufficiency, on the other hand, is said to be a temporary sliding or slight prolapse of the cardiac portion of the stomach without participation of the peritoneum. The author feels, however, that the size of the hernia is not a valid criterion and that the peritoneum cannot be demonstrated roentgenographically. Therefore, he wishes to reserve the term hiatus "hernia" only for the congenital type with short esophagus and he calls the acquired type "hiatus insufficiency" with the following three subdivisions: (a) simple hiatus insufficiency, (b) hiatus insufficiency with axial hernia and (c) hiatus insufficiency with paraesophageal hernia.

In the course of a year the author has observed 14 cases of hiatus insufficiency out of a total of 1,230 gastric examinations (1.14 per cent), 9 cases of simple hiatus insufficiency, 3 cases with paraesophageal hernia and 2 cases with axial hernia.

In the differential diagnosis diverticulum of the

lower esophagus has to be excluded. This is a rare condition and, in contradistinction to hitaus insufficiency, can be easily recognized, even in the erect posture.

Six roentgenographic reproductions are included to illustrate the different types of hiatus insufficiency. —*E. Kraft, M.D.*

Frimann-Dahl, J. The administration of barium orally in acute obstruction; advantages and risks. *Acta radiol.*, Oct., 1954, *42*, 285–295.

Barium sulphate suspended in water, combined with some substance to prevent flocculation was used, giving the patients 50 cc. of suspension, two parts barium sulphate to three parts water.

This was swallowed by the patient and then the patient was placed on his right side for a more rapid emptying of the stomach. The progress was observed at frequent intervals to localize the obstruction and when possible to determine the type or cause of obstruction.

This procedure was used in all cases in which the diagnosis was not obvious from the usual film and the clinical findings. In all 512 cases which were studied over a seventeen year period about 50 per cent were given the barium sulphate. This did not produce any serious complications and was of considerable aid at times. No complication resulted from the mixture entering the free peritoneal space on a few occasions.

If the obstruction is in the colon, a barium enema should be the diagnostic procedure of choice since barium by mouth may increase the degree of obstruction in colon lesions.—*V. L. Peterson, M.D.*

Godart, J., and van Lerberghe, R. Le grêle du gastrectomisé. Etude fonctionnelle radiologique. (The small intestine in the gastrectomized; functional roentgenologic study.) *Acta gastro-enterol. belg.*, Nov., 1954, *17*, 776–779.

This is a motility study of 60 gastrectomized patients. The material consists of cases with and without the clinical dumping syndrome.

The gastrointestinal motility was studied first with barium suspended in water and afterward with a milk and sugar mixture and still later with a mixture containing three eggs. The impression gained from this study is that the small intestine follows the same pattern regardless of whether a clinical dumping syndrome exists or not. A motor disturbance is not seen in all cases with subtotal gastrectomy, and when the gastrojejunal stoma functions well, the function of the small intestine is also good.

Dilatation of the jejunal loops occurs frequently, but may be absent in spite of existence of the dumping syndrome. It is merely a sign of jejunal hypotonicity, and since it is sometimes observed immediately following ingestion of barium, it cannot be a forced distention.

Rugal thickening is considered a normal phenomenon during digestion and may disappear rapidly. Segmentation of the ileum denotes a hypertonic condition and occurs frequently together with dilatation of jejunal loops.

Hypermotility of the small intestine with a transit time of only ten to twenty minutes has been observed in cases with and without the dumping syndrome.

The authors conclude that abnormal physiology of the small intestine is caused by roughly digested food in patients with subtotal gastrectomy. It may favor the development of the dumping syndrome, but the real cause of this syndrome must be found in the intestinal wall or beyond its border.—*Ernest Kraft, M.D.*

Crozier, Henry C. Hand-operated barium pump assembly for examination of the colon. *Radiology*, Nov., 1954, *63*, 734–735.

The author describes and amply illustrates a pump for use as a booster for thick barium in double contrast examination of the colon. The desirable features of this device are: (1) It is easily disassembled for cleaning. (2) The flow of barium is under direct control and can be stopped at will. (3) The pump does not build up a back pressure against resistance to the flow, such as could occur with an obstructing lesion of the bowel. (4) An air insufflator may be joined conveniently to the tubing with a check valve to prevent contaminating the insufflator with barium.

A permanent bracket to be attached to any roentgenographic table is described for use with the pump.—*Michael J. Healy, M.D.*

Coller, Frederick A., and Regan, William J. Difficulties of diagnosis of some lesions of colon. *A.M.A. Arch. Surg.*, Oct., 1954, *69*, 516–524.

The surgeon is guided in determining his plan of operation of a lesion of the colon by a knowledge of whether the lesion is inflammatory (specific or nonspecific) or neoplastic, and if neoplastic whether benign, potentially malignant or malignant.

The role of the history, the physical examination, sigmoidoscopy and roentgenologic investigation is considered in connection with this determination. The discussion concerns the small minority of cases in which a definite diagnosis of the nature of the lesion cannot be made. Lesions in various parts of the colon are described. Very briefly a clinical history, the roentgen diagnosis, the operative diagnosis and/or procedure are given, as well as the final pathological diagnosis.

Roentgenographic reproductions are included demonstrating some typical cases of regional ileitis, ileocecal tuberculosis and carcinoma of the cecum,

as well as inflammatory and neoplastic lesions of the transverse and distal colon and rectum, and endometriosis. In a few instances the roentgenographic characteristics of the lesions were very atypical and as a result the roentgenographic diagnosis was in error. In some of these cases even the operative findings were atypical and the true diagnosis could not be made until the diseased tissue was examined under the microscope.—*Paul R. Dirkse, M.D.*

FIGIEL, LEO S., and FIGIEL, STEVEN J. Volvulus of the transverse colon. *Radiology*, Dec., 1954, *63*, 832–836.

Volvulus of the transverse colon is one of the rarest forms of mechanical obstruction of the large bowel. A review of the 26 cases previously reported in the literature reveals a scarcity of reference material on the roentgenologic features of this entity. Roentgen findings on barium enema study suggestive of a volvulus of the transverse colon are a rounded termination of the injected barium at the site of obstruction with distention and redundancy of the transverse colon proximal to the site of obstruction. Crossing and spiraling of the mucosal folds at the site of obstruction on the post-evacuation roentgenogram is conclusive evidence of the presence of a volvulus.

A case of volvulus of the transverse colon occurring as a result of herniation through a tear in the transverse mesocolon in which pathognomonic evidence of torsion was demonstrated on the barium enema studies is presented.—*Harold C. Hamilton, M.D.*

BACHMAN, ARNOLD L. Roentgen appearance of gastric invasion from carcinoma of the colon. *Radiology*, Dec., 1954, *63*, 814–822.

Four cases, over a period of a year, of primary carcinoma of the transverse colon in which the stomach was invaded by direct extension are discussed. The roentgen picture, although the degree of gastric involvement varied, was sufficiently similar and characteristic to suggest the diagnosis.

The more common causes of a gastrocolic fistula, frequently observed in this condition, are listed as follows: (a) carcinoma of the stomach, (b) carcinoma of the colon, or (c) as a complication of gastroenterostomy. Less common causes are due to (d) other malignant neoplasms in the abdomen, (e) penetrating abdominal wounds, such as stab and gunshot, (f) intra-abdominal abscess, (g) syphilis and tuberculosis.

The close anatomical relationship of the greater curvature of the stomach to the distal three-fifths of the transverse colon permits direct extension from the colon to the stomach by way of the connecting gastrocolic ligament. It is on this posterior aspect of the greater curvature that the filling defect is characteristically found. As the appearance of this gastric extension is determined by the degree of invasion, the roentgen examination may show: (1) a simple crescentic indentation on the greater curvature of the stomach, (a) a large crescentic defect with a deep central ulcer crater, (3) a defect with ulceration and a fistulous tract.

The differential diagnosis includes: (1) *intramural neoplasms* such as leiomyoma and leiomyosarcoma of the stomach. Only the demonstration of a fistulous tract will rule out a primary intramural tumor. (2) *Primary neoplasms of the greater curvature* of the stomach such as carcinoma, lymphosarcoma, and Hodgkin's disease usually are not sharply circumscribed, may show an overhanging shelf, are not of regular crescentic shape, and usually demonstrate irregular destruction of the gastric mucosa rather than simple flattening. (3) *Other intra-abdominal neoplasms* such as pancreatic tumors, liver tumors and splenic tumors can usually be differentiated by the different location of the pressure defect. These tumors rarely cause fistulas. (4) *Gastrocolic fistulas due to other causes* than colon cancer invasion have been listed above. In cases of cancer of the stomach extending to the colon, the roentgen appearance of the stomach resembles more closely that of primary carcinoma than of intramural tumor.

Clinically, despite the origin in the colon, many patients present symptoms which are predominantly gastric in nature. The clinician must be aware of this and must not stop further gastrointestinal roentgen examination when the gastric lesion on the greater curvature is found. Operative exploration may offer much palliation even when a fistula is present; therefore, these patients should have a complete work-up so the true condition may be realized and prepared for.—*Donald N. Dysart, M.D.*

GENITOURINARY SYSTEM

PÉTKOVIC, S. La radiologie des voies urinaires dans les tumeurs du tube digestif. (Roentgenography of the urinary tract in gastrointestinal tract tumors.) *Presse méd.*, Oct. 27, 1954, *62*, 1452–1454.

Roentgenologic evidence of involvement of the urinary tract by gastrointestinal tumors assists in preoperative diagnosis, particularly in regard to operability and choice of surgical approach.

Radical operation usually can be effected with tumors of the pelvic colon and probably the right colon even with urinary tract involvement. Tumors of the rectum and small intestine are seriously compromised and radical operation may not be possible. However, absence of this involvement does not necessarily mean a good prognosis. Changes in the urogram in cases of globular tumors of the abdomen regardless of origin do not always indicate inoperability but increase the surgical difficulties. Prognosis is not seriously impaired except in the case of sarcoma.—*Marcy L. Sussman, M.D.*

Williams, D. Innes. The radiological diagnosis of lower urinary obstruction in the early years. *Brit. J. Radiol.*, Sept., 1954, *27*, 473–483.

This article deals with lower urinary tract obstructions of a chronic nature which will cause retention of urine and dilatation of the ureters.

The methods used for roentgenological investigation are: (1) Intravenous pyelography. This method usually gives information only as to the effects of the obstruction and not as to its nature. It should not be attempted in a child whose blood urea is over 100 mg. per 100 cc. Roentgenograms of the bladder taken before, during and after micturition give information comparable with that obtained from cystograms. (2) Simple urethrography. This performed by the injection method alone is hardly ever of assistance; it will only show the distal point of the obstruction and the anterior urethra, because only a fine stream of opaque medium will pass the obstruction and therefore cannot dilate the proximal urethra. (3) Micturating cysto-urethrography. This is a routine method for children over three to four years in age with no chronic retention of urine. The procedure is discussed, noting that the medium used is 10–15 per cent diodone. (4) Cysto-urethrography. The author feels that this is a valuable method when investigating babies. It is done under general anesthesia in the operating room immediately prior to operation on the obstructive lesion or the establishment of adequate drainage of the urinary tract. The method is discussed.

The following types of obstruction are considered:

In the anterior urethra diverticula due to congenital deformity or trauma occur; these are best demonstrated by the micturating cysto-urethrogram.

In the posterior urethra a relatively common abnormality is the formation of obstructing valvular folds of mucous membranes below the verumontanum. The appearance seen in a micturating cysto-urethrogram is urethral dilatation, bladder neck hypertrophy, and often a filling defect of the verumontanum. An important diagnostic point is the observation of the demarcation of the actual folds running down from the verumontanum. Another cause of obstruction in the posterior urethra is a congenital stricture in the region of the membranous urethra which also presents a dilatation of the prostatic portion.

Obstruction at the level of the perineal membrane will give a picture where the dilatation gradually tapers down to a point at the level of the external sphincter instead of showing the bulging laterally which is evident in the valvular obstructions. The true nature of this type of obstruction has yet to be determined. Agenesis of the abdominal muscles, usually in boys, will give a similar urethrogram, likewise of unknown etiology.

Other lesions causing obstruction of the urethra are acquired strictures due to fractures of the pubes, neurological disorders giving a neurogenic bladder and disorders of the prostate.

Bladder neck obstruction may occur in children. This is usually due to a hypertrophied bar of muscle thickening the internal sphincter. Roentgenographic evidence is hard to obtain in this condition; however, a deformity seen in the expression cysto-urethrogram may be characteristic of the disease. This consists of a forward projection of the posterior lip of the bladder neck on a lateral film. Another cause of bladder neck obstruction may be a bladder tumor, usually rhabdomysarcoma, showing a filling defect in the cystogram. Finally, ureterocele-like dilatation at the termination of an ectopic ureter, opening a little below the bladder neck, may cause bladder neck obstruction.

The author ends by discussing the effects of obstruction which are: hypertrophy of bladder muscles giving trabeculations; filling defects due to a hypertrophied inter-ureteric bar on a lateral film; sacculation of the bladder; and dilatation of the ureters. He notes that ureterovesical reflux, a common finding in chronic cases of obstruction, is an occasional event in the normal urinary tract of children.—*Wallace M. Roy, M.D.*

Klami, Paavo. Retrograde pyelography with hydrogen peroxide in the contrast medium; a preliminary report. *Acta radiol.*, Sept., 1954, *42*, 181–188.

The indications and contraindications are the same as those for ordinary retrograde pyelography. The author advocates the addition of hydrogen peroxide to the contrast medium for visualization of ulcerative processes in the upper urinary tract. (He had previously used it to demonstrate such conditions in the esophagus.) There is formation of foam and elevation of the contrast medium from the site of the ulcerative process due to the capacity of pus cells and of blood to decompose the hydrogen peroxide into oxygen and water. It appears that some contrast media are decomposed by hydrogen peroxide. The author used Uriodone Forte containing the diethanoamine salt of 3:5 di-iodo-4-pyridone-N-acetic acid 50 per cent w/v. This will decompose in time, but if used immediately after preparation, it has not appeared to be irritating. Three per cent of hydrogen peroxide in the medium is used when only a few erythrocytes and leukocytes were encountered in the urine sample, and 1.5 per cent when they were present in abundance.

The first pyelogram is taken as soon as possible after the medium fills the renal recesses. A second exposure is made about fifteen seconds later, and subsequent ones at intervals at one-half to one minute for a total of about four exposures, usually with one or two in an oblique position. The injection may be done with or without fluoroscopic control.

Experiments were first carried out on pig's kidneys, post mortem. Four case histories of patients in which this procedure was used are reported. Three of these were diagnosed tuberculosis of the kidney and one hypernephroma. In the cases of renal tuberculosis, foam formation of more or less local character was visible, depending upon the extent of the lesions. When no erythrocytes or leukocytes were present in the urine a contrast medium to which hydrogen peroxide had been added gave a filling contour which was identical to that produced by an ordinary contrast medium.

This is a preliminary report. It seems that the principle, when developed further, will prove useful. —*Paul R. Dirkse, M.D.*

Chamberlin, George W., and Imber, Irving. Pyelography for the diagnosis of lesions of the body and tail of the pancreas. *Radiology*, Nov., 1954, *63*, 722–729.

Lesions of the body and the tail of the pancreas may produce significant pressure effects upon the left kidney. In some instances they produce changes in the left pyelogram.

The authors report a series of 6 patients who were found to have either carcinoma, carcinoma with retention cysts, or benign cyst of the pancreas. They describe the changes in the excretory urogram of the left kidney produced by these mass lesions. The renal parenchymal shadow is slightly broadened and occasionally elongated. The calyces appear stretched out and spindle-shaped without displacement, obstruction or amputation. The renal pelvis shows varying degrees of compression deformity. The proximal ureter may be displaced posteriorly or laterally. Actual posterior displacement of the renal parenchymal shadow may sometimes be seen in the lateral pyelogram. If the kidney is not fixed by the pancreatic mass, the evidence of compression will be lost when the patient is placed in the erect position.—*A. W. Sommer, M.D.*

Warres, Herbert L., and King, Albert C. Hyaluronidase in intramuscular excretory urography. *Radiology*, Nov., 1954, *63*, 730–733.

The authors studied the effects of hyaluronidase on the rate of absorption of diodrast and neo-iopax administered intramuscularly. Into one buttock they injected either diodrast 35 per cent or neo-iopax 50 per cent in amounts varying from 6 to 10 cc. plus 1 cc. of 2 per cent procaine solution. Into the other buttock, they injected the same mixture, to which had been added hyaluronidase in quantities of 150 to 750 TUR (turbidity reducing units). Nine patients were tested in this manner. In 9 others the hyaluronidase was not mixed directly with the solution of the medium and procaine, but was first dissolved in 2 cc. of normal saline and injected into the buttock. Then, without moving the needle, the medium-procaine solution was administered. Roentgenograms were taken at ten minute intervals. The optimum times were found to be twenty, forty and sixty minutes.

It is concluded that hyaluronidase does not facilitate the absorption of diodrast 35 per cent or neo-iopax 50 per cent administered intramuscularly.—*A. W. Sommer, M.D.*

Crawford, T., Dent, C. E., Lucas, P., Martin, N. H., and Nassim, J. R. Osteosclerosis associated with chronic renal failure. *Lancet*, Nov. 13, 1954, *2*, 981–988.

The history, clinical, laboratory and autopsy findings in 3 cases of chronic renal failure, showing bone sclerosis, are discussed in detail. The literature concerning reports of similar cases is reviewed and an attempt to analyze the cause of this variation is presented.

The cases reported each showed bone sclerosis, 1 generalized and 2 in the vertebral bodies. In 1 case there was an associated hyperplasia of the parathyroids with "osteitis fibrosa." The 2 cases of vertebral sclerosis showed changes suggestive of hypogonadism and the nephritic process developed early in life.

Current knowledge of bone metabolism seems inadequate to explain these findings in renal failure, however the authors believe it is more common than the reports in the literature indicate.—*V. L. Peterson, M.D.*

Swoboda, W., and Rupp, W. Das klinische Bild der Vitamin-D-resistenten Rachitis (Typus "Phosphatdiabetes"). (The clinical picture of vitamin D resistant rickets; type—"phosphate diabetes.") *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Nov., 1954, *81*, 582–590.

The main cause of vitamin D resistant rickets is to be found in the kidneys. In true renal rickets, the disturbance is in the tubules, while in renal osteodystrophy the seat of the disorder lies in the glomeruli. In one renal rickets syndrome there is disturbance in the phosphorus metabolism; other substances, like aminoacids and glucose, may also show abnormal metabolism and excretion. The most common type is the one with disturbances in the phosphate metabolism.

Familial occurrence is very common. In five of the families observed by the authors, the mothers were affected three times.

The deformities of the legs in severe vitamin D resistant rickets are usually due to varus of the distal ends of the tibiae, while in renal rickets the varus seems to involve more often the neck and shaft of the femur. Clinically the main symptom is a

markedly diminished serum phosphorus and an elevation of the alkaline serum phosphatase.

The roentgen findings are those of active rickets. The epiphyseal changes are not as marked as in rickets of infants. A generalized coarse osteoporosis is present. The hips often show a coxa vara. The deformity of the femur seems particularly marked.

The etiological factor is a disturbance of the mineral metabolism, especially of phosphorus, on a constitutional and hereditary basis. Increased excretion of phosphorus by the kidneys and decreased re-absorption in the tubules seems well demonstrated.

The treatment consists of very high and continuous doses of vitamin D. The serum phosphatas value becomes more normal, but the serum phosphorus remains uninfluenced and low. Clinically the result of such treatment is usually satisfactory, but depends on long continued dosage. These large doses of vitamin D may become dangerous when the patient is immobilized for considerable time, for instance after orthopedic measures. Nephrocalcinosis may develop. Orthopedic measures should not be instituted too early; medical treatment is essential for good result. Many problems as to the action of vitamin D on the phosphorous metabolism remain unsolved.—*H. W. Hefke, M.D.*

Nervous System

Schneider, Richard C., Cherry, Glenn, and Pantek, Henry. The syndrome of acute central cervical spinal cord injury; with special reference to the mechanisms involved in hyperextension injuries of cervical spine. *J. Neurosurg.*, Nov., 1954, *11*, 546–577.

The acute cervical cord syndrome is characterized by disproportionately greater motor impairment of the upper extremities than the lower extremities, bladder dysfunction, and varying degrees of sensory loss below the lesion. There may be a gradual return of function with the recovery occurring first and best in the lower extremities, next in the bladder, and last and least in the upper extremities. The finer finger movements are the very last to return. If the injury is severe the lesion may progress upward and/or downward and cause death.

The above syndrome is usually produced by hyperextension injuries. It frequently occurs without a fracture or dislocation, and in these cases it probably is due to buckling of the ligamentum flavum, compressing the cord between the bulge of the ligamentum and the bony spinal canal. If posterior spurs extend from the vertebrae, the compression against these spurs is likely to produce more extensive damage than if the spurs were not present.

Surgical intervention in these cases is contraindicated as most of them will recover spontaneously. Operations have actually been proved to harm the patient. If any marked degree of recovery is to be expected, then some recovery of motor function should occur in the first few hours after injury. Myelography is usually contraindicated due to the manipulation it requires.

The authors review 6 cases from the literature and present 9 cases of their own.—*Frank M. Windrow, M.D.*

Skeletal System

Vinson, Harold A., and Schatzki, Richard. Roentgenologic bone changes encountered in frostbite, Korea 1950–51. *Radiology*, Nov., 1954, *63*, 685–695.

This study is based upon a series of 100 soldiers who incurred frostbite in Korea between December, 1950, and March, 1951. The majority had suffered rather severe cold injury. Seventy per cent were classified third degree frostbite on the basis of four degrees of soft tissue damage.

Repeated examinations of the involved extremities were done to determine the alterations in bone structure. Sixty-four patients showed bone changes at some time. These changes were classified into four groups, as follows:

Group A: Osteoporosis: When it occurred, it was usually present in the fourth to the tenth week after exposure. Of interest was the extreme rarity of a severe degree of osteoporosis during any stage of the observation period and its complete absence after six months following injury.

Group B: Acromutilation (bone changes following exposure to air): This group included 9 patients. Mutilation of the tips of the extremities, particularly the tufts of the great toes, has been attributed directly to exposure to cold. Analysis of these cases shows that overlying soft tissue damage had allowed exposure of the underlying bone to air with subsequent destruction by osteomyelitis or actual surgical removal.

Group C: Late changes close to joints of hand and feet: Juxta-articular bone changes were found in 7 patients and did not become noticeable until several months after cold exposure. The lesions consisted of small, usually round, punched out areas of decreased density which later were frequently surrounded by a margin of dense bone. In most instances a connection between the lesions and the joint spaces could be shown. The etiology of these lesions is obscure. Direct cold injury to the bone is unlikely in that the overlying soft tissues in some instances showed very little evidence of frostbite. Roentgenologically, the lesions resemble those of rheumatoid arthritis and occasional cases of degenerative arthritis of the hands and feet. Thus, injury to the joint cartilage may be common to all three. Further studies, both pathological and experimental, are needed to complete the study of these findings.

Group D: Other bone changes: This group included 4 cases not readily classified otherwise. Two

men showed periostitis. Another patient showed early disintegration of the middle phalanx of the fifth toe in an area of mummification, possibly due to osteomyelitis. The fourth patient showed a defect in the terminal tuft of a toe without evidence of exposure of the bone to air.—*Michael J. Healy, M.D.*

Craig, W. S. Gargoylism in a twin brother and sister. *Arch. Dis. Childhood*, Aug., 1954, *29*, 293–303.

The author presents a very complete study of the clinical and social features of twins afflicted with gargoylism. The obstetrical history was normal. No gargoylism was found in the family but a paternal great-aunt died at the age of three years and was a deaf mute. A maternal great-uncle was kyphotic from the age of three but led a relatively normal life. Several distant ancestors were dwarfed without having had characteristics of gargoylism or achondroplasia.

The female twin developed the evidence of gargoylism a few months later than the male twin but once the disease was well established at the age of eighteen months it progressed more rapidly in the girl than in the boy. At birth the girl was accepted as normal but, in retrospect, the father thought the boy had coarse facial features and a large head at birth.

The boy was lazy and irritable his first year of life but after that he began to show evidence of interest in life and some ability to carry on normal function in spite of the deformities. He succumbed to bronchopneumonia at the age of four years and eight months. His sister was good natured and relatively normal in her development until the age of one. Then she became lazy and irritable and continued that way until the age of five when she worsened to extreme listlessness and inactivity before dying at the age of seven years of bronchopneumonia and heart failure.

Some of the clinical features noted include corneal opacities, conjunctivitis, rhinorrhea, macroglossia, gum hyperthrophy, dolichocephaly, kyphosis, neuromuscular imbalance, deafness, heart murmurs, hepatosplenomegaly, genu valgum and flexion deformities of the joints.

Roentgenologically there was evidence of thick, short humeri, a characteristic malformation of the 2nd lumbar vertebra with posterior displacement, delayed ossification, and "typical" bony changes of the hands, feet, long bones, skull and pelvis.—*W. Donald Janney, M.D.*

Tompkins, Winslow T., and Wiehl, Dorothy G. Epiphyseal maturation in the newborn as related to maternal nutritional status. *Am. J. Obst. & Gynec.*, Nov., 1954, *68*, 1366–1377.

Using the epiphyseal centers at distal end of femur, proximal end of tibia and os calcis, an attempt was made to ascertain the effect of nutrients during pregnancy on the maturation of these growth centers. A control group received a marginal diet with no supplement. Three other groups received vitamin supplement, protein supplement, and vitamin and protein supplement respectively. Three hundred term infants constituted the total group.

The results indicate a great variation in the maturation of epiphyseal centers at birth. Moreover, the more mature a center at birth, the less is its further maturation during the first month of life, and vice versa, so that variation is less as time goes on. At birth, the least difference by race and sex is found for the distal end of the femur (absent at birth in only 1.3 per cent of the whole group) which is the most advanced; and the greatest difference is found for the os calcis, which is the latest of these three to be present in most babies. In general, the centers appear earlier in Negroes than in whites, and, in each racial group, in the females earlier than in the males. The authors state that it appears that the proximal tibial epiphyseal center (absent at birth in 20.6 per cent of the whole group) should be present in a mature term infant and that it is a more sensitive index of infant maturity than the others but it is not clear how they arrive at this conclusion. In infants of patients receiving a supplemental diet there was a significantly greater probability that the proximal tibial epiphyseal center would be present at birth. The data are thought to give suggestive evidence that nutritional factors may affect the efficiency with which the growth mechanism functions but, in this group, the supplements given did not alter the appearance of the epiphyseal centers to any marked degree.—*H. G. Peterson, M.D.*

Alantar, I. H., and Gürson, C. T. Regarding the transition of a case of the "Abt-Letterer-Siwe" disease to "lipoid granulomatosis." *J. Pediat.*, Nov., 1954, *45*, 590–598.

The reticuloendothelioses include: (1) eosinophilic granuloma, (2) Abt-Letterer-Siwe disease and (3) Hand-Schüller-Christian disease. These have come to be regarded as different forms in a spectrum of the same fundamental abnormality, the etiology being unknown. Transition forms, though rare, have been recorded.

The case, reported in this article presented symptoms consistent with both Abt-Letterer-Siwe disease and Hand-Schüller-Christian disease (lipoid type). Otorrhea, fever, and papillary and petechial skin eruptions constituted the initial manifestations. Diabetes insipidus and exophthalmos appeared later. Hepatosplenomegaly, lymphadenopathy, hypochromic anemia, elevated blood cholesterol and jaundice were also present. Roentgenograms showed punched-out defects in skull, ribs, and tibiae which may be identical in all three types of reticuloendotheliosis. There were also massive hilar shadows.

The disease (Abt-Letterer-Siwe) is fatal; few

cases survive. No specific treatment is yet available though some have reported favorable response to roentgen therapy and to antibiotics.—*H. G. Peterson, M.D.*

Kessler, Althea D., Scott, Roland B., Kelley, Charles H., and Steinman, Ruth. Cystic tuberculosis of the bones in children; report of two cases. *A.M.A. Am. J. Dis. Child.*, Aug., 1954, *88*, 201–209.

Tuberculosis of the long bones in children usually attacks the metaphysis, with early caseation and abscess formation. Less commonly, single or multiple tuberculous foci are found in the diaphyses, with localized thinning of the cortex and formation of cyst-like structures. These tuberculous cysts may remain stationary for long preiods, may progress to abscess formation, or more frequently may heal without complication. Such cyst-like areas in roentgenograms of the long bones, especially when unaccompanied by sinus or abscess formation, may present problems in differential diagnosis. For this reason the authors present two cases of cystic tuberculosis of the bones.

One patient, with a solitary cystic area in the humerus, recovered completely without specific therapy. The second case had multiple cystic lesions involving the skull, vertebrae, and the long bones. With streptomycin, paraminosalicylic acid, and isoniazid therapy, the skull and long bones healed in a period of one and one-half years, but extensive pulmonary tuberculosis is still present.

The clinical picture of the cases presented conformed to Law's modification of Jüngling's classic description of cystic tuberculous bone disease in early childhood. This modification is as follows: (1) the disease occurs in children; (2) the long hollow bones may be involved; (3) the presence of cutaneous lesions is not necessary for the diagnosis; (4) the tuberculin test may be positive; (5) the primary tuberculous focus is nearly always intrathoracic. According to Jüngling, skin lesions were associated with his cases and the roentgenographic picture consisted of circumscribed areas of rarefaction without periostitis or sequestration. Periosteal involvement was, however, present in both the cases reported.—*Ralph S. Bromer, M.D.*

Norell, Hans-Gösta. Roentgenologic visualization of the extracapsular fat; its importance in the diagnosis of traumatic injuries to the elbow. *Acta radiol.*, Sept., 1954, *42*, 205–210.

Pads of fat are present normally on the ventral and dorsal aspects of the humerus immediately above the capsule of the elbow joint. The ventral layer of fat may be visible normally as a zone of increased transparency, but in the normal individual the dorsal layer is obscured by the condyles. In the presence of a fracture of the distal end of the humerus, the ventral layer of fat is frequently displaced ventrally to a varying degree. In addition the dorsal layer is frequently displaced posteriorly so that it becomes visible in the lateral view of the elbow. The displacement of the fat layer is believed to be due to intra-articular effusion or hemorrhage, or extracapsular hemorrhage. In may be observed also in various forms of arthritis in which effusion is present. —*Paul R. Dirkse, M.D.*

Winston, John R., and Moreton, Robert D. Panel discussion on low back pain. Objectives of the preplacement x-ray investigation of the low-back area. *Radiology*, Nov., 1954, *63*, 664–666.

Pre-employment physical examinations are being done more and more in modern industry on persons seeking employment in order that such person may be placed in a job that is most compatible with his capabilities. Roentgenographic investigation of the low back area as part of this examination is only recently becoming more widespread.

The authors discuss the procedure followed by the Atchison, Topeka and Santa Fe Railway System in their roentgenographic investigation of prospective employees. Roentgenograms in four views, the anteroposterior, lateral, and right and left 45 degree obliques of the lumbosacral area, are taken. A radiologist inspects the wet films and classifies the prospective employee into one of the following groups:

Class I: No abnormalities.
Class II: Abnormalities not associated with clinical back complaints.
Class III: Abnormalities rarely associated with clinical back complaints.
Class IV: Abnormalities occasionally associated with clinical back complaints.
Class V: Abnormalities often associated with clinical back complaints.

This report, phoned in by the radiologist, along with the other preplacement examinations, enables the employing officer to place the employee in a job best suited to his capabilities, thereby protecting the safety, well-being and earning capacity of not only the employee and employer, but of his fellow workers as well.—*Donald N. Dysart, M.D.*

Moreton, Robert D., Winston, John R., Bibby, Douglas E., and Williams, Claude. Panel discussion on low back pain. Radiologic considerations in preplacement examinations of the lumbar spine; summary of four thousand consecutive cases. *Radiology*, Nov., 1954, *63*, 667–672.

Four thousand consecutive pre-employment roentgenographic examinations of the low back were studied in order to evaluate and determine the incidence of spondylolisthesis and that of isthmus de-

fects. As a criterion for spondylolisthesis the perpendicular line test or Garland sign was used, according to which the vertebral body must have slipped sufficiently to touch a perpendicular line from the anterior tip of the vertebral body just below. Meschan's method of measuring the angle formed along the posterior surface of the involved vertebra was employed for grading the amount of slip.

The incidence of spondylolisthesis in these 4,000 examinations was from 2.7 to 5.3 per cent per 1,000 or about 4 per cent for the 4,000 cases, with the last lumbar segment most frequently involved. There were found to be 272 isthmus defects or spondylolysis in these cases. Most of these were bilateral and affected the last lumbar vertebra.

A discussion of the etiology of isthmus defects is presented by the authors. It is felt that with a narrow sclerotic neural arch, especially in association with an increased sacral angle, there appears to be a tendency for weight-bearing to be more upon the isthmus leading to eventual neural arch separation following repeated minor trauma.—*Donald N. Dysart, M.D.*

Ewing, Charles L. Panel discussion on low back pain. Medicolegal radiology. *Radiology*, Nov., 1954, *63*, 673–677.

This article is written by the General Claims Attorney for the Atchison, Topeka and Santa Fe Railway system. The probability that any case referred to a radiologist today involves a medicolegal problem is so great that he must gear all of his procedures with that probability in mind.

Terminology used in roentgenologic reports must be such that there can be no misinterpretation by lay juries. Use of the words "old fracture" in describing an injury under treatment may lead to confusion. "No definite evidence" of fracture, dislocation or other bone pathology, or "no significant bone anomalies" are phrases which can be interpreted to mean that there was *some* evidence—thereby reversing the intent of the report. The best procedure is to make the reports positive and accurate, such as reporting the roentgen findings concerning trauma first and then the roentgen findings not connected in any way with trauma.

Should the radiologist be required to testify in court, a conference with the attorney handling the case is always a wise step. This enables the attorney to get the facts for preparing his case and appraises the radiologist of the issues in the case and the kind of questions to expect and prepare for. Use of the words "possible," "probable," "definite," and so on in testifying may lead to misinterpretation. The radiologist must be positive in his opinion. Besides positively identifying the films about which he is testifying, the radiologist must be complete and accurate in stating what he sees on the films.

In conclusion, the author states that all any reputable attorney wants of a radiologist is his careful considered opinion, couched and supported in courageous positive language unqualified by weak-kneed speculation.— *Donald N. Dysart, M.D.*

Potter, R. M., and Norcross, J. R. Panel discussion on low back pain. Spondylolisthesis without isthmus defect. *Radiology*, Nov., 1954, *63*, 678–681.

Attention is called to a degenerative arthritic process with erosion of joint facets as a cause of spondylolisthesis. An isthmus defect permitting forward slipping of the involved vertebral body (most frequently lumbar) has been recognized as the most frequent cause.

Differentiation between spondylolisthesis resulting from isthmus defect and that due to degenerative arthritic erosion of the facet joints is not difficult on good lateral films. If an isthmus defect is the cause, the anteroposterior dimension of the involved vertebra is increased and the spinous process of the vertebra above moves forward so that there may be a palpable offset. If an arithritic process is the cause, there is no increase in the anteroposterior dimension of the vertebra and the spinous process of the involved segment moves forward so that the vertebra below may be palpable.

This process is more common between the 4th and 5th lumbar segments. The intervertebral foramina are frequently encroached upon by the marginal productive bone reaction leading to symptoms of root pressures.

The authors state that in the interest of accurate diagnosis accurate definition of the character of the lesion causing the spondylolisthesis is desirable.— *Donald N. Dysart, M.D.*

Fiebelkorn, H.-J. Über Aufhellungsstreifen (sog. Vakuum-Phänomen) in den lumbalen Zwischenwirbelscheiben. (Translucent streaks [so-called "vacuum phenomenon"] in the lumbar intervertebral discs.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Nov., 1954, *81*, 601–605.

The so-called "vacuum phenomenon" in lumbar intervertebral discs has been described and found to exist in 2 per cent of the roentgenograms of the lumbar spine.

The author examined 1,094 roentgenograms of the lumbar spine, and found it present in 3.6 per cent of his cases. The condition is very rarely seen in the anteroposterior view. Most of the spines with this sign showed degenerative changes and scoliosis.

The lumbosacral joint was the most common seat but occasionally more than one interspace was involved. The finding could be reproduced or made to disappear fairly regularly by positioning, that is, overextension or upright position. The transparent

zone appeared or disappeared immediately after the change in position.

The vacuum phenomenon is only one of the manifestations of degeneration of the intervertebral discs due to tear of the disc substance.

It is not clear, as yet, if the radiolucent streaks are due to air or to a vacuum. While a similar appearance in other joints is proved to be due to gas entering a vacuum, it remains questionable, in the opinion of the author, if gases can enter such a desiccated and degenerated disc. The sudden appearance and disappearance of the phenomenon also seems to speak against gas causing it.—*H. W. Hefke, M.D.*

Sugar, Oscar, and Bucy, Paul C. Some complications of vertebral angiography. *J. Neurosurg.*, Nov., 1954, *11*, 607–615.

Three cases in which cerebral angiography led to complications are presented. In 2 of these multiple injections were made, filling the vertebral and internal carotid arterial systems. In the other only the carotid was filled. Two died during the forty-eight hours following the procedure. The other developed marked central neurological changes. All 3 showed advanced arteriosclerotic changes in the vertebral and internal carotid arteries.

The authors suggest several precautions to follow to lessen the hazards of intracranial angiography. First, they thought that a relatively long wait between successive injections (a minimum of 10 minutes) may reduce the hazards. If the first angiogram shows advanced arteriosclerosis, occlusion or any pronounced delay in the circulation, the procedure should be discontinued. The roentgenogram should include the tip of the needle, so that if there is an extravasation or injection into the vessel wall it will be known. Vasospasm following extraluminal injection may contraindicate additional injections. They stress again the use of as small a quantity of the contrast medium as possible.—*Frank M. Windrow, M.D.*

Epstein, Joseph A. The syndrome of herniation of the lower thoracic intervertebral discs with nerve root and spinal cord compression; a presentation of four cases with a review of the literature, methods of diagnosis and treatment. *J. Neurosurg.*, Nov., 1954, *11*, 525–538.

The author reports 4 proved cases of protruded thoracic intervertebral discs which were successfully diagnosed by neurological examination and myelography. He thinks myelography is of primary importance in establishing the definite diagnosis and states that often the myelographic defect can be seen only at fluoroscopy but frequently can be shown on films.

He stresses accurate diagnosis before surgery and then very cautious surgical approach. He advises against removal of spurs which may accompany the protruded discs and suggests adequate decompression. He removed all of the protruded discs with very little residual neurological deficit. All of his cases were relatively early and he says this is essential if good results are to be obtained. In all of his patients an abdominal lesion was suspected before the final diagnosis was made. Two of them had surgery, one pelvic and the other thoracic.

If an accurate diagnosis is made early and careful, meticulous surgery done, good results may be obtained in a majority of cases.—*Frank M. Windrow, M.D.*

Alperin, Leonard J., and Bender, Martha J. Osteitis pubis. *A.M.A. Am. J. Dis. Child.*, Aug., 1954, *88*, 227–233.

Osteitis pubis, according to the authors, is a very rare clinical entity in the pediatric age group. It occurs post-traumatically and manifests itself by severe pain over the area of the pubic symphysis, painful micturition and defecation and painful pseudoparalysis. It is a self-limited disease and complete resolution occurs within a year.

A case of osteitis pubis in a six year old Negro boy is presented in this article. After several examinations, osteomorosis of the pubic rami was visible in the roentgenograms. Repeated examinations of the pelvis revealed rapidly progressing destruction of the bone about the symphysis. An aspiration of the left pubic bone was performed and small amounts of material were obtained. Smears were inconclusive. No eosinophils or granuloma cells were seen. A culture of the material showed no growth.

Trauma, infection, or a combination of both have been considered as etiologic factors. Structurally the disease may vary from a periostitis to extensive lesions of bones with necrosis of cartilage and bone followed by subsequent healing, and infrequently, by hyperostosis. As yet, no specific method of treatment has been found. Sulfonamides and other antimicrobial agents seem to be of no avail, although some feel that penicillin shortens the clinical course. Bed rest is most important and in severer cases, immobilization with plaster jackets or traction frames may be necessary. Roentgen therapy, diathermy and radiant heat have been used to alleviate the symptoms.—*Ralph S. Bromer, M.D.*

Stutter, B. D. The complications of "osteitis pubis"; including a report of a case of sequestrum formation giving rise to persistent purulent urethritis. *Brit. J. Surg.*, 1954, *42*, 164–172.

"Osteitis pubis" as a descriptive term appears to have been introduced by Rochet and Legueu in 1923.

Constant severe pubic and perineal pain, which invariably radiates down the inner side of the thighs

along the distribution of the obturator nerves, is a clinical characteristic.

From the roentgenologic standpoint bilateral osteoporosis of the bony component of the symphysial synchondrosis is a dominant feature. A study of the development, blood supply and morbid histology in osteitis pubis, together with a consideration of the well recognized dangers to which its blood supply and nutrition are liable in trauma to the symphysis and retropubic operations, may reveal that the primary lesion is avascular necrosis of the interpubic disc of fibrocartilage and that osteoporosis is a complication of that condition.

In the present reported case of persistent purulent urethritis caused by sequestrum formation secondary to osteitis pubis, the sequence of events is considered in the light of the hypothesis of avascular necrosis of the public disc fibrocartilage as the etiological factor. Secondary infection, as well as providing a stepping stone toward the extrusion of sequestra and the formation of urinary and osseo-urinary fistulae, might also be responsible for the occurrence of a true pyogenic osteomyelitis following osteitis pubis. In addition, such a hypothesis might help to simplify treatment which could consist of the safe operative procedure of excision of the dead interpubic disc. This procedure might avoid all the complications associated with the natural response to the presence of dead tissue and reduce the duration of disablement. —*C. N. Borman, M.D.*

Blood and Lymph System

Figley, Melvin M. The significance of variations in angiocardiographic circulation times. *Radiology*, Dec., 1954, *63*, 837–848.

Chamber filling and emptying times obtained from short-interval angiocardiography were studied. The time of appearance and disappearance of contrast of the individual heart chambers and vessels was estimated in normal and congenitally abnormal hearts by a single observer. Later the films were reviewed in large groups, to facilitate recognition of slight changes of density, influence of respiration, Valsalva effort, hepatic reflex, etc. The details of the techniques employed are presented.

Normally, the right heart clears rapidly with complete clearing of the main pulmonary arteries by the time of initial opacity of the ascending aorta, and the latter was chosen as the end point for estimation of right heart clearing.

In the patients with left to right shunts, the time for mitral aortic opacification is normal, but there is prolonged pulmonary artery opacification. There is also prolongation of left heart clearing, due to recirculation.

Pulmonary stenosis and pulmonary hypertension can result in delayed clearing of the right ventricle and delayed aortic opacification. Of course, in patients with tetralogy of Fallot, the right ventricle clears rapidly because of the direct access of the ventricle to the aorta. Patients studied with mitral valve disease, constrictive pericarditis, and idiopathic congestive heart failure had greatly retarded initial aortic opacification times.

Coarctation of the aorta produced no abnormality of the rate of right heart circulation.

Evaluating intrathoracic circulation times by conventional angiocardiographic methods is far from exacting. The Valsalva effect and hepatic reflex must be considered, and although the significance of hepatic reflex has not been fully explored, it probably is abnormal if it occurs after vena caval clearing. Other defects are the lack of a record of heart rate during filming and the fact that the present rate of filming is too slow for infants. Work to evaluate and possibly eliminate these difficulties is proceeding.—*C. L. Stevenson, M.D.*

Vogler, E. Angiographische Beiträge zur Entstehung von Gefässerkrankungen und Durchblutungsstörungen unter besonderer Berücksichtigung der terminalen Strombahn. (Angiographic contributions to the etiology of vascular diseases and circulatory disturbances with special attention to the terminal blood stream.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Oct., 1954, *81*, 479–497.

Serial angiography permits an insight into the functional disturbances of the blood stream even before organic changes in the vascular walls can be demonstrated microscopically. The peripheral blood stream consists of arterioles, capillaries, venules, and many small arteriovenous anastomoses, which under certain conditions may bypass the capillary network. The technique in examining the lower extremities is to inject 17 cc. of a 35–50 per cent contrast medium under normal pressure into the femoral artery against the stream (after local anesthesia with 2 per cent novocaine). One film is taken immediately after the injection. Seven minutes later, a second injection is made with 40 cc. of a 50 per cent solution. Serial films, five to seven, are taken at 3 sec. intervals; two additional films are taken 5–10 sec. apart.

In normal individuals (*i.e.*, without detectable cardiac or peripheral vascular disease), the contrast material is well seen in the large, medium and smaller arteries, fades from view as it enters the peripheral blood stream (where it is too diluted), and is visualized again as it courses through progressively larger veins. The opaque medium is better concentrated in the deeper than in the superficial veins; there is no evidence of vascular dilatation; and no change in the caliber of the vessels is noted on comparison of films taken before and after intra-arterial injection of hydergin (Sandoz). Hydergin is a peripheral vascular drug containing a

mixture of ergot preparations and it is particularly suitable for the study of functional disturbances in the peripheral circulation.

In pathological conditions of the peripheral vascular system, serial angiography points to two types or sites of disease in the arterial side of the peripheral blood stream, depending on whether the lesion is distal or proximal to the arteriovenous anastomoses:

(1) If distal, the opaque medium circulates immediately through small dilated veins; opacification of the superficial veins is seen in the arterial phase; the opaque medium passes directly from small arteries into dilated veins by means of the wide open anastomoses. The arteries are also dilated because the larger blood supply in the veins acts as a resistance to the adequate flow from the arterial to the venous side. In a retrograde manner, the venous side of the capillary system is also dilated. Proof that the lesion in the arterial portion of the peripheral blood stream is distal to the arteriovenous anastomoses is seen in the fact that after hydergin, the effect of which is to diminish the element of obstruction and to close the anastomoses, the opaque medium courses normally through the capillary system. Also, the caliber of the superficial and deep venous channels, as well as the caliber of the arteries, is diminished. Of course, if the lesion is of long-standing, originally functional disturbances give way to organic changes and a return to a normal circulation is incomplete. Continuation of the process leads to generalized vascular disease.

(2) If proximal the opaque medium circulates slowly through the smaller arteries. This delay has been termed "prestenotic stasis" because the obstruction is not in these arteries but in the arterial side of the peripheral blood stream. Opacification of the deep veins is delayed and poor in intensity because the capillary system also receives only a small amount of the opaque medium. After hydergin, the circulation may improve as indicated by an increase in the caliber of the arteries and a better flow through the anastomoses. A return to normal circulation is rarely possible, for the changes in the peripheral blood stream are already organic in nature. The obstructing lesion is in the arterial portion of the peripheral blood stream, since at this time no microscopic changes can be detected in the larger vessels. Since venous dilatation cannot occur in the presence of open arteriovenous anastomoses, the site of the obstruction must be proximal to the latter, which consequently receives a diminished blood supply. Because a similar diminution exists in the capillary system, nutritional disturbances arise.

The described changes are at first functional and so minor as to produce no clinical signs or symptoms, nevertheless they represent initial stages of potentially serious generalized vascular disease. Spastic phenomena in the peripheral blood stream can be demonstrated angiographically. Similar spasms are probably responsible for pathological changes in the larger arteries. Since the vasa vasorum or nutrient vessels are part of the peripheral blood stream, it is postulated that the initial stage of generalized vascular disease occurs in the periphery. Progressive venous dilatation produces diffuse changes, characterized by a decrease in elasticity of the venous walls. Prolonged organic changes in the arterial system are characterized by extensive necrosis. The pathological disturbances in the veins are more permanent, particularly if the valves are involved.—*Joseph Zausner, M.D.*

Maxwell, G. M., and Waisman, H. A. Peripheral vascular disease with gangrene and hemiatrophy in a child of three years. *A.M.A. Am. J. Dis. Child.*, Nov., 1954, *88*, 606–610.

In this article a case of obliterative peripheral vascular disease in a three and a half year old child is reported. The lesion, present for at least two and one-half years, was considered to be thromboangiitis obliterans. Gangrene of a toe had occurred, and the affected limb was smaller than the normal contralateral. The age at onset, site and clinical features were considered unusual.

Examination by femoral arteriography of both lower extremities was performed. The caliber of the arteries which were visualized on the right (affected) side was narrowed, and the luminal contour was irregular. Only one of the major arteries of the lower leg was visualized, the posterior tibial. No vascular filling was seen in the foot. On the left side which was clinically unaffected, opacification of the vessels extended to the foot. The caliber of the vessels was distinctly larger than on the right side. The femoral artery had a smooth lumen.—*Ralph S. Bromer, M.D.*

Hochman, A., and Czerniak, P. Hodgkin's disease and amyloidopathia. *Radiology*, Nov., 1954, *63*, 716–721.

It is suggested that a pathological condition formerly described as "lardaceous disease" and later as amyloidosis would be better termed "amyloidopathia" or "amyloidoforme infiltration." Amyloidopathia may be primary or secondary to other conditions. These latter include: (a) suppurative chronic foci in the body as tuberculosis, osteomyelitis, bronchiectasis, abscess, etc.; (b) nonsuppurative chronic processes, as syphilis, chronic arthritis, multiple myeloma, malaria, and Hodgkin's disease.

The physical features, laboratory findings and cause of relationship of amyloidopathia with Hodgkin's disease are described.

According to statistics from the literature, about 2 per cent of cases of amyloidopathia are associated with Hodgkin's disease. Two case reports of these associated diseases are presented.

The cases suggest that (1) a comparative Congo red test may lead to the establishment of the diagnosis where the absolute result of this test is not

decisive; (2) that the early diagnosis of amyloidosis may be of some importance, since adequate treatment may possibly retard the deposition of amyloid substance; (3) that the appearance of amyloidopathia worsens the prognosis of Hodgkin's disease and may lead to death from uremia.—*E. E. Seedorf, M.D.*

MISCELLANEOUS

LAUGHLIN, JOHN S. Symposium on radiation units. Intensity and absorbed dose rate. *Radiology*, Nov., 1954, *63*, 646–655.

The most important concepts in the quantitative measurement of radiation are the output of the source of radiation, and the absorbed dose produced in tissue by the absorption of the radiation. These quantities have been defined by the International Commission on Radiological Units. The definition of intensity is based on the amount of energy flowing through a unit area (expressed in ergs per square centimeter per second), and the absorption dose is defined as the amount of energy imparted to matter by ionizing particles per unit mass of irradiated material at the point of interest, expressed in rads. The use of these absolute units is very desirable, but two important questions immediately arise. First, how can the output and the absorbed dose be expressed in absolute units, and second, what is the relationship of our conventional ionization measurements to absolute intensity and absorbed dose rate.

In consideration of the above questions one must remember that when roentgen rays are absorbed in any medium, energy is imparted to secondary electrons. These electrons lose their energy through ionization and excitation of the atoms of the absorbing medium. Unless chemical change results, all this energy is eventually converted into heat. The average energy lost by an electron per ion pair formed has been determined accurately. Consequently, a measurement of ionization can be related to energy per unit mass of the absorbing body absorbed from the beam, which is the absorbed dose, and also to the energy flux density, which is the intensity of the incident beam.

The direct measurement of energy absorbed in air (that is, the energy flowing through a unit area per unit time), and the direct measurement of absorbed dose in tissue are both extremely difficult. It has been shown, however, that there is a direct relationship between the amount of ionization in a small air cavity and the energy absorbed in the surrounding wall material. The interpretation of ionization density measurement in air cavity chambers to give the absorbed dose in the surrounding absorbing medium rests on the principles underlying the Bragg-Gray relation. By measurement of ionization, and use of the above mentioned relationship to the surrounding wall material, it can be shown that the definition of the roentgen corresponds to the absorption in 1 gram of air of about 84 ergs. From the use of an appropriate formula, the energy absorption in other materials in terms of the roentgen may be determined. It will be noted that at low photon energies one roentgen of radiation produces in bone an absorbed dose of about 5 rads, whereas in fat it produces an absorbed dose of only about 0.5 rad.

The quantity of radiation (intensity×time) required to produce one roentgen can also be expressed by an appropriate formula after determination of the true absorption part of the total linear attenuation coefficient for air, and the density of air.

Although the preceding calculations and discussions of the relationship between a simple ionization measurement and the quantity of radiation (intensity×time) and absorbed dose apply to the particular case of roentgen-ray beams, similar calculations may be made for the electron beam.

Although relatively simple ionization measurements can be interpreted to give both absorbed dose rate and intensity for both roentgen-ray and electron beams, it is desirable to measure these quantities more directly. This can be done directly by calorimetric methods. For intensity measurement, a heavy absorbing medium such as lead is used to totally absorb the incident beam. The temperature rise in the absorbing block is then measured by means of the resistance change of a thermistor.

The absorbed dose can be measured experimentally by combining the calorimetric determination of the quantity of radiation and a measurement of the distribution of the absorbed energy in the absorbing medium. Distribution can be measured with an ionization chamber. Description of the laboratory technique for this measurement is given.

The intensity of electron beams can be determined with the aid of a Faraday cage measurement. In this measurement, knowledge of the area of beam and of the energy spectrum of the electrons gives the intensity in ergs per square centimeter per second. The absorbed dose produced in a medium by the absorption of the electron beam can be determined by a combination of integrated energy distribution measurements and Faraday cage intensity measurements.—*A. Ralph Watson, M.D.*

MARINELLI, LEONIDAS D. Symposium on radiation units. Radiation dosimetry of internally administered beta ray emitters: Status and prospects. *Radiology*, Nov., 1954, *63*, 656–663.

The evaluation of the absorbed dose in biological media containing radioactive isotopes has been the object of excellent studies. This article summarizes concisely the present status of the art, and speculates as to its future prospects (considerations being limited to beta ray emitters).

The problem is treated most simply by considering the dose at a given point P in a medium under three general conditions. In the first of these condi-

tions, the point P is within a homogeneous medium containing a uniform concentration of radioelement extending from P to distances greater than the range R, of the most energetic particle emitted by the isotope. The solution to this problem is relatively easy when the given formula is used, although it is actually of limited value in many biological problems. It has, however, proved useful in guiding both the physician to the rapid attainment of optimum radiotherapeutic dosage, and the health physicist to the establishment of approximate permissible radioactive burdens in the human body.

In the second consideration the point P is within a spherical surface of radius R, the point in question being only partially surrounded by one or more zones of uniform concentration. This consideration, though of theoretical and experimental value, has little practical importance to the radiologist, since it is concerned with phenomena at the surface of separation between uniform concentration and no concentration.

The third problem considered is the determination of the absorbed dose at point P within a sphere of radius R, in which the concentration is not uniform, regardless of the spatial extent of the radioactive zone. This is more difficult to calculate than that of the other conditions considered, since the value of the concentration in microcuries per gram depends on the location of the infinite-simal volume element and must be determined independently beforehand everywhere within the sphere of radius R. This difficulty could be overcome by experimental means by the use of photographic emulsion. The author gives an excellent discussion of the type of photographic emulsion needed, and its possible use, in this problem.—*A. Ralph Watson, M.D.*

Coltman, John W. The scintillation limit in fluoroscopy. *Radiology*, Dec., 1954, *63*, 867–875.

The author states that the ultimate performance which can theoretically be obtained with a fluoroscopic imaging device is determined by the quantum nature of the roentgen rays themselves. Research here reported was therefore undertaken to make a direct determination of the capabilities of an ideal fluoroscope limited only by quantum fluctuations. Two problems presented themselves. First, it was necessary to determine the number of significant x-quanta available at the screen, and second, to determine the ability of the eye to integrate a scintillating picture into a meaningful pattern. With these data, the performance of an ideal image intensifier over the entire range of fluoroscopic conditions could be predicted.

Although it had been previously customary to calculate the number of quanta available by converting roentgens into quantum densities, this method was believed to introduce inaccuracies, so a direct measurement was made by means of a scintillation counter. The maximum counting rate was corrected for scattered radiation and converted to quanta per square millimeter per second. A curve was then drawn to show the quanta available in fluoroscopy for various phantom thicknesses and detector positions.

An ideal image intensifier would receive only information-bearing roentgen-ray signals from the subject and construct therefrom an image of arbitrary size and brightness. Neither size nor brightness would then limit the eye's ability to recognize the content of the picture. Such an apparatus was simulated by displaying on a television kinescope a bar pattern delineated by bright dots derived from a roentgen-ray source. The scintillation counter was mounted behind a long vertical slit. In front of this was rotated a square-toothed wheel opaque to rentgen rays, so that when a tooth obscured the lower part of the slit, a decrease in the scintillation rate resulted. This arrangement provided an accurate simulation of an ideal roentgen-ray intensifier examining a small area of picture containing a resolving-power grid of adjustable contrast.

With this apparatus, a determination was made of pattern contrast necessary for recognition of the presence of a pattern. Four observers were tested in a manner which assured an objective evaluation of their ability to discern the pattern, and results obtained demonstrated a remarkable ability of the eye to distinguish a pattern among the scintillations.

With the data obtained, it was possible to determine, in lines per mm., the resolution limit of an ideal intensifier operating at any phantom thickness. One is somewhat surprised to find that the scintillation limit of resolution lies well beyond the limits set by the more common shortcoming of fluoroscopic systems. Or, stated in a different manner, an intensifier which is limited in resolution only by the scintillation effect could outperform screen-roentgenography by sizable factors. In view of these findings, the question of what brightness gains would be useful no longer seem very significant. Since even at high brightness and contrast levels the eye cannot achieve resolving powers much over 12 lines per millimeter, it is evident that over a considerable range of conditions the eye limit will be reached before the scintillation limit, so that one would desire an amplification sufficient to bring the image to the brightness level for optimum critical viewing.—*A. Ralph Watson, M.D.*